2. CLOSURE OF ELECTROPLATING EQUIPMENT

The Plating Operations decommissioning project began on July 1, 1986. Mr. Robert Wilroy, Senior Engineer of Talbert Cox & Associates, Columbia, South Carolina provided supplemental training for employees who performed the decommissioning. During the decommissioning project Mr. Wilroy joined the firm of Post Buckley Schuh and Jernigan in Columbia, South Carolina. Mr. Wilroy's training course (ref. Exhibit 2.1) included chemistry of plating bath treatment, removal of heavy metals, coagulation, sludge dewatering, operation processes, safety, and first aid.

After the training course had been completed, the project was divided into three phases to facilitate an orderly decommissioning.

The three phases are as follows:

1. Processing of the plating baths and rinsewaters.
2. Removal of the electroplating hardware and machinery.
3. Clean-up and pressure washing of the plating shop.

Phase 1. The processing of the rinsewaters and plating baths through the wastewater treatment plant began on July 27, 1986. The rinsewaters and plating baths were routed into the wastewater treatment facility at a controlled rate to ensure that discharges from the treatment facility were within pretreatment guidelines established by the Allegheny County

Sanitary Authority for this facility. Frequent sampling of rinsewaters and plating baths prior to discharge to the wastewater treatment facility was conducted to determine the proper amount of treatment chemicals to be added. Adjustments were made in the treatment process and wastewater flow rates, as appropriate, to maintain compliance with provisions of the pretreatment permit.

This procedure was followed until all plating lines had been processed. The final line was completed on May 25, 1987. The wastes from the wastewater treatment plant and the plating tank bottoms were disposed of in accordance with all Federal, State, & local regulations (ref. Exhibit 2.2 State Manifests NYA 4100332, PAB 4671166, PAB 4671133, PAB 4671306, PAB 4671214, PAB 4671225).

Phase 2. Removal of all hardware and machinery from the plating building was conducted between June 1, 1987 and June 30, 1987 by Payson Associates Inc. of Southfield, Michigan. All material not purchased by Payson Associates was properly disposed of in accordance with all applicable federal and state regulations.

The fianl phase, phase (3), the clean-up and pressure washing of the plating operation began on September 3, 1987. All work was performed with U.S.&S. labor. A mild detergent (Citra-Clean) was used in the pressure washing of the building. All rinsate was processed through the wastewater treatment plant. The project was completed September 23, 1987.

WASTE TREATMENT
OPERATORS
TRAINING COURSE

UNION SWITCH & SIGNAL DIV.
AMERICAN STANDARD CO.
SWISSVALE, PA.

TALBERT, COX & ASSOCIATES, INC.
JULY 1986

WASTE TREATMENT
OPERATOR TRAINING
COURSE OUTLINE

Introduction

Purpose Of Training Course
Type of Information - not over anyone's head
Hours course will be handled - participation/questions
Information directly related to operation

Background

Basic Math
- Metric System
- Common Conversions

Basic Chemistry
- Reactions
  - Acids
  - Alkalies
  - Salts
  - Oxidation/Reduction
  - Reversible
- Conductivity
- pH-
  - Definition
  - Use
  - Buffers
- Time
- Temperature Rise
- Precipitation/Solubility

Chemistry of Treatment

Cyanide

Sodium Cyanide

Metal Complexes

Oxidation with Chlorine Compounds

Cyanide Continue to Destruction

Two stage reaction

Function - pH - micro amp reading

ORP - milli volt reading

Spec. conductance - micro ohm voltage

Chrome Reduction

Reducting Compounds

SO_2, $Na_2S_2O_5$, $NaHSO_3$

Reation

Function - pH

ORP

Time

To Prevent Reversal

Remove Chromium

Precipitation

Function pH

Remove Other Heavy Metals

Precipitation as Bicarbonates (HCO_3)

or Carbonates (CO_3) or as Hydroxides (OH)

Lime or Caustic

Lead - Must be by Bicarbonates - Use Soda Ash ($NaHCO_3$)

Ni, Cu, Zn, Cr, Cd, - as (x) (OH)

Coagulation
  Description
    To collect and add weight to enhance settling coagulant
    Coagulant aids - polyelectrolyte or polymers
    Flash Mixing
    Flocculation
    Settling
      Theory
      (Lamella Unit)
    Separation of the Solids
      Sludge
      Supernatant or Effluent

Sludge Dewatering
  Physical Separation
    Settling - Gravity
    Filter Press - Mechanical

Actual Plant Process

Plant Flow Sheet
  Details
Problems:
  (1) No Provision for chrome treatment, (therefore, will do in the process tanks)
  (2) Only one stage cyanide treatment provided
  (3) Chemical feed units set up for rinse waters only, (20-70 mg/l)

- Plant Walk Through
  - Discussion of each unit
    - Cyanide Treatment
    - Neutralization or pH Adjustment
    - Pump Sump
    - Lamella Separator
    - Sludge Holding Tank
    - Filter Press
  - Discussion of Instrumentation
    - Reading
    - Meanings
    - Calibration
  - Discussion of Chemical Feed Equipment
    - Limitations - Volume Feed Rate
      Automatic Controls
    - Chemicals Used
  - Hands on Operation

  - Present Operating Problems
    - Mechanical
      - Chemical Feed Limitations
      - Pumps
        - Types being used
        - Centrifugal
        - Air diaphram (Wildens)
        - Level controls
    - Process
      - Excess Heavy Metals in Effluent
      - Out of pH range
        - Cyanide Treatment Unit
        - Neutralization Unit
        - Pump Sump
        - Lamella Unit
        - Effluent
        - Carry over of cyanides into effluent
        - Excess chlorine

Check daily or more frequently

- CN
- Cr^T
- Heavy metal being discharged
  - (more later)
- pH - (Lab Test) Effluent
  - CN Unit
  - Pump Sump

Observations of Lamella Results

Operation of Sludge Filter Press

Repairs Needed

Repairs Made

Vistors - Name and Purpose of Visit

SAFETY

General

Chemicals

- Sodium Hypochloride
- Sodium Metabisulfite/Sodium Bisulfite
- Sulfuric Acid
- Caustic (Sodium Hydroxide)
- Lime
- Polyelectrolyte

Testing
- Laboratory
  - Equipment - Test Kits
  - pH —
  - Conductivity
  - Cyanides
  - Heavy Metals
    - Chrome
    - Cadmium
    - Copper
    - Nickel
    - Zinc

Record Keeping
- Lab Tests
  - Date
  - Time
  - Analysis Being Made
  - Analysis Results
  - Name of Person Making Analysis

Waste Plant Operation
- Date
- Time
- Operator
- General conditions of waste treatment plant
- Morning reading of instruments
- Noon reading of instruments
- Afternoon reading of instruments
- Results of treatment
- Unusual Operations

48-14-1 (4/85)

STATE OF NEW YORK
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
DIVISION OF SOLID AND HAZARDOUS WASTE

Exhibit 2.1

HAZARDOUS WASTE MANIFEST

P.O. Box 12820, Albany, New York 12212

Please print or type.

Form Approved. OMB No. 2000-0404. Expires 7-31-88

UNIFORM HAZARDOUS WASTE MANIFEST	1. Generator's US EPA No. / Manifest Document No.	2. Page 1 of	Information in the shaded areas is not required by Federal Law.
	PAD000001155 / [illegible]	1	

3. Generator's Name and Mailing Address
Union Switch and Signal
Div. of American Standard
5800 Corporate Drive
Pittsburgh, PA 15237

4. Generator's Phone (412) 244-3183

5. Transporter 1 (Company Name) — 6. US EPA ID Number
MacMat Environmental Group, Inc. — NYD980769047

7. Transporter 2 (Company Name) — 8. US EPA ID Number

9. Designated Facility Name and Site Address — 10. US EPA ID Number
CECOS International, Inc.
56th Street and Pine Avenue
Niagara Falls, NY 14304 — NYD980336241

GENERATOR

11. US DOT Description (Including Proper Shipping Name, Hazard Class and ID Number)	12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol
a. RQ Hazardous Waste Solid, N.O.S., ORM-E NA 9189 F006	032	DM	11200	P
b. RQ Hazardous Waste Solid, [illegible] N.O.S., ORM-E, NA 9189 F008	001	DM	00200	P
c.				
d.				

J. Additional Descriptions for Materials Listed Above
F006
F008/D007 F009

15. Special Handling Instructions and Additional Information
Items: A) Product code 11551-AAD, 20 55-gallon drums and [illegible] 85-gallon drums containing Chromium & Cadmium (WO #262333)
B) Product code 11551-AAC, 1 85-gallon drum
Product code 11551-AAE, [illegible] 55-gallon drums, non-hazardous non-regulated

16. GENERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked and labeled, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations and state laws and regulations.
Unless I am a small quantity generator who has been exempted by statute or regulation from the duty to make a waste minimization certification under Section 3002 (b) of RCRA, I also certify that I have a program in place to reduce volume and toxicity of waste generated to the degree I have determined to be economically practicable and I have selected the method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment.

Printed/Typed Name	Signature	Mo.	Day	Year
M.D. Tourdot	M.D. Tourdot	10	31	87

TRANSPORTER

17. Transporter 1 (Acknowledgement of Receipt of Materials)

Printed/Typed Name	Signature	Mo.	Day	Year
Richard J. O'Connor	Richard J. O'Connor	10	31	87

18. Transporter 2 (Acknowledgement or Receipt of Materials)

Printed/Typed Name	Signature	Mo.	Day	Year

FACILITY

19. Discrepancy Indication Space — LINE A #11, LINE B #11 & I, J CHANGES APPROVED BY M TOURDOT

20. Facility Owner or Operator: Certification of receipt of hazardous materials covered by this manifest except as noted in item 19.

Printed/Typed Name	Signature	Mo.	Day	Year
DAVID P JAROSZEWSKI	[signature]	11	03	87

EPA Form 8700-22 (Rev. 4-85) Previous edition is obsolete. **COPY 3—Generator—mailed by TSD facility**

In case of emergency or spill immediately call the National Response Center (800) 424-8802 and the N.Y. Department of Transportation (518) 457-7382.

PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL RESOURCES
Bureau of Waste Management
P. O. Box 2063
Harrisburg, PA 17120

Exhibit 2.2

Please print or type. (Form designed for use on elite (12-pitch) typewriter.)
ER-SWM-51:REV. 10/86 Form Approved. OMB No. 2050-0039 Expires 9-30-88

In case of an emergency or spill immediately call the National Response Center (800) 424-8802 and the PA DER (717) 787-4343

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator's US EPA ID No. P A D 0 0 0 0 0 1 1 1 5 | Manifest Document No. 0 0 0 0 8 | 2. Page 1 of 1 | Information in the shaded areas is not required by Federal law but is required by State law.

3. Generator's Name and Mailing Address
Union Switch and Signal
1761 Braddock Avenue
Swissvale, PA 15218

4. Generator's Phone (412) 273-4183

A. State Manifest Document Number: PAB 4671166

B. State Gen. ID:

5. Transporter 1 Company Name: 7-7, Inc.

6. US EPA ID Number: O H B 0 0 0 7 7 2 5 5 8

C. State Trans. ID: PA-AH | 0 2 3 8

7. Transporter 2 Company Name:

8. US EPA ID Number:

D. Transporter's Phone (800) 221-6096

E. State Trans. ID: PA-AH

9. Designated Facility Name and Site Address

10. US EPA ID Number:

F. Transporter's Phone ( )

G. State Facility's ID: Not Required

H. Facility's Phone ( )

11. US DOT Description (Including Proper Shipping Name, Hazard Class, and ID Number)	12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol	I. Waste No.
a. Hazardous waste solid N.O.S. ORM-E NA 9189	0 0 1	C M	2 0	Y	D 0 0 6
b.					
c.					
d.					

J. Additional Descriptions for Materials Listed Above (include physical state and hazard code)

	Haz. Code	Physical State	Haz. Code	Physical State
a.	E	S	c.	
b.			d.	

K. Handling Codes for Wastes Listed Above
a. Secure Landfill
b.
c.
d.

15. Special Handling Instructions and Additional Information
WO #262254
PC 11551-AAC
Buffalo # 1 KES Job #312082

16. GENERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations.
If I am a large quantity generator, I certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and that I have selected the practicable method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment; OR, if I am a small quantity generator, I have made a good faith effort to minimize my waste generation and select the best waste management method that is available to me and that I can afford.

Printed/Typed Name: Marcel David Tourdot | Signature: [signature] | Month 1 0 | Day 0 6 | Year 8 7

TRANSPORTER

17. Transporter 1 Acknowledgement of Receipt of Materials
Printed/Typed Name: Dennis L. Anderson | Signature: Dennis L Anderson | Month 1 0 | Day 0 6 | Year 8 7

18. Transporter 2 Acknowledgement of Receipt of Materials
Printed/Typed Name: | Signature: | Month . | Day . | Year .

FACILITY

19. Discrepancy Indication Space #11a) Add(F008) waste #1. Should be F008 not D006
Per Rich Hiltz KA.

20. Facility Owner or Operator: Certification of receipt of hazardous materials covered by this manifest except as noted in Item 19. 35,220#

Printed/Typed Name: Kat Heaton | Signature: Kat Heaton | Month 1 0 | Day 0 7 | Year 8 7

PAB 4671166

EPA Form 8700-22 (Rev. 9-86) Previous editions are obsolete

COPY 3 – TSD FACILITY: MAIL TO GENERATOR

PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL RESOURCES
Bureau of Waste Management
P. O. Box 2063
Harrisburg, PA 17120

Exhibit 2.3

Please print or type. (Form designed for use on elite (12-pitch) typewriter.)
ER-SWM-51:REV. 10/86 Form Approved. OMB No. 2050-0039 Expires 9-30-88

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator's US EPA ID No. P A D 0 0 0 6 0 1 1 1 3 — Manifest Document No.

2. Page 1 of 1 — Information in the shaded areas is not required by Federal law but is required by State law.

3. Generator's Name and Mailing Address: Union Switch and Signal Division of American Standard, Inc. 5800 Corporate Drive Pittsburgh, PA 15237

4. Generator's Phone (412) 244-3183

A. State Manifest Document Number: PAB 4671133

B. State Gen. ID:

5. Transporter 1 Company Name: 7-7, Inc.

6. US EPA ID Number: O H D 0 0 0 7 7 2 5 5 8

C. State Trans. ID: PA-AH 0 2 3 4

7. Transporter 2 Company Name:

8. US EPA ID Number:

D. Transporter's Phone (800) 221-6096

E. State Trans. ID: PA-AH

9. Designated Facility Name and Site Address: CECOS International Inc. Aber Road Williamsburg, Ohio

10. US EPA ID Number: O H D 0 8 7 4 3 3 7 4 4

F. Transporter's Phone ( )

G. State Facility's ID: Not Required

H. Facility's Phone (513) 724-6114

11. US DOT Description (Including Proper Shipping Name, Hazard Class, and ID Number)	12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol	I. Waste No.
a. RQ Hazardous Waste Solid N.O.S. (Cadmium) ORM-E NA9189	0 0 1	CM	2 0	Y	D002 D 0 0 6
b.					
c.					
d.					

J. Additional Descriptions for Materials Listed Above (include physical state and hazard code)

	Haz. Code	Physical State		Haz. Code	Physical State
a.	E	S	c.		
b.			d.		

K. Handling Codes for Wastes Listed Above

a. Secure Landfill
b.
c.
d.

15. Special Handling Instructions and Additional Information

PC 11551-AAB
WO# 262148 KES Project No: 31208

16. GENERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations.
If I am a large quantity generator, I certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and that I have selected the practicable method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment; OR, if I am a small quantity generator, I have made a good faith effort to minimize my waste generation and select the best waste management method that is available to me and that I can afford.

Printed/Typed Name: M.D. Tourdot — Signature: M.D. Tourdot — Month Day Year: 0 9 2 5 87

17. Transporter 1 Acknowledgement of Receipt of Materials

Printed/Typed Name: Dennis L. Anderson — Signature: Dennis L. Anderson — Month Day Year: 0 9 2 5 8 7

18. Transporter 2 Acknowledgement of Receipt of Materials

Printed/Typed Name: — Signature: — Month Day Year:

19. Discrepancy Indication Space
Box I: omit D002, A D F008 per Ron Prahasky
Box 11(A): should read RQ, WASTE CYANIDE DRY MIXTURE, (D006, F008) POISON-B, UN1588. per same
27,580#

20. Facility Owner or Operator: Certification of receipt of hazardous materials covered by this manifest except as noted in Item 19.

Printed/Typed Name: Ron Louderback — Signature: Ron Louderback — Month Day Year: 09 26 87

EPA Form 8700-22 (Rev. 9-86) Previous editions are obsolete

COPY 3 – TSD FACILITY: MAIL TO GENERATOR

GENERATOR / TRANSPORTER / FACILITY

In case of spill immediately call the National Response Center (800) 424-8802 or (202) 426-2675

PAB 4671133

PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL RESOURCES
Bureau of Waste Management
P. O. Box 2063
Harrisburg, PA 17120

Exhibit 2.4

Please print or type. (Form designed for use on elite (12-pitch) typewriter.)

ER-SWM-51:REV. 10/86 Form Approved. OMB No. 2050-0039 Expires 9-30-88

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator's US EPA ID No. PAD000003111 Manifest Document No. 50001

2. Page 1 of — Information in the shaded areas is not required by Federal law but is required by State law.

3. Generator's Name and Mailing Address
Union Switch and Signal
1789 S. Braddock Ave. Pittsburgh, PA. 15218

4. Generator's Phone ( ) —

A. State Manifest Document Number: PAB 4671306

B. State Gen. ID:

5. Transporter 1 Company Name: 7 - 7 Inc.

6. US EPA ID Number: OHD000772555

C. State Trans. ID: PA-AH

7. Transporter 2 Company Name:

8. US EPA ID Number:

D. Transporter's Phone (800 221-6096

E. State Trans. ID: PA-AH 0238

9. Designated Facility Name and Site Address
Cecos International Inc.
5092 Aber Road
Williamsburg, Ohio 45176

10. US EPA ID Number: OHD087433774

F. Transporter's Phone ( )

G. State Facility's ID: Not Required

H. Facility's Phone (513 724-6114

11. US DOT Description (Including Proper Shipping Name, Hazard Class, and ID Number)	12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol	I. Waste No.
a. Hazardous Waste Solid N.O.S. ORM-E NA 9189 (D-006)	001	CM	20000	P	D006
b.					
c.					
d.					

J. Additional Descriptions for Materials Listed Above (include physical state and hazard code)

	Haz. Code	Physical State		Haz. Code	Physical State
a.	T	S	Cadmium and Cyanide con & Debris		
b.					
c.					
d.					

K. Handling Codes for Wastes Listed Above

a. Landfill	c.
b.	d.

15. Special Handling Instructions and Additional Information
WO# 261032
PC# 11551-AAB
EES Buff Job # 312082

16. GENERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations.
If I am a large quantity generator, I certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and that I have selected the practicable method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment; OR, if I am a small quantity generator, I have made a good faith effort to minimize my waste generation and select the best waste management method that is available to me and that I can afford.

Printed/Typed Name: M. D. Feundeh — Signature: [signature] — Month Day Year: 09 04 87

17. Transporter 1 Acknowledgement of Receipt of Materials

Printed/Typed Name: MICHAEL NUMBERS — Signature: [signature] — Month Day Year: 09 04 87

18. Transporter 2 Acknowledgement of Receipt of Materials

Printed/Typed Name: — Signature: — Month Day Year:

19. Discrepancy Indication Space

20. Facility Owner or Operator: Certification of receipt of hazardous materials covered by this manifest except as noted in Item 19.
36,020#

Printed/Typed Name: Kent Heaton — Signature: [signature] — Month Day Year: 09 08 87

EPA Form 8700-22 (Rev. 9-86) Previous editions are obsolete

COPY 3 – TSD FACILITY: MAIL TO GENERATOR

GENERATOR — TRANSPORTER — FACILITY

In case of an emergency or spill immediately call the National Response Center (800) 424-8802 and the PA DER (717) 787-4343

PAB 4671306

P. O. Box 2063
Harrisburg, PA 17120

ER-SWM-51:REV. 10/86

Please print or type. (Form designed for use on elite (12-pitch) typewriter.)
Form Approved. OMB No. 2050-0039 Expires 9-30-88

Exhibit 2.5

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator's US EPA ID No. P A D 0 0 0 0 0 1 1 1 5 | Manifest Document No. 0 0 0 0 2

2. Page 1 of 1 | Information in the shaded areas is not required by Federal law but is required by State law.

3. Generator's Name and Mailing Address
Union Switch and Signal
1789 S. Braddock Ave. Pittsburgh, PA. 15218
4. Generator's Phone (412) 244-3183

A. State Manifest Document Number PAB 4671214

B. State Gen. ID

5. Transporter 1 Company Name — 7 - 7 Inc.

6. US EPA ID Number O H D 0 0 0 8 7 7 2 5 5 8

C. State Trans. ID PA-AH

7. Transporter 2 Company Name

8. US EPA ID Number

D. Transporter's Phone (800 321 6094

E. State Trans. ID PA-AH 0 2 3 8

9. Designated Facility Name and Site Address
Cecos International Inc.
5092 Aber Road
Williamsburg, Ohio 45176

10. US EPA ID Number O H D 0 8 7 4 3 3 7 4 4

F. Transporter's Phone ( )

G. State Facility's ID Not Required

H. Facility's Phone (513 724-6114

11. US DOT Description (Including Proper Shipping Name, Hazard Class, and ID Number)	12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol	I. Waste No.
a. [illegible] (D-006) N.O.S. ORM-E NA 9189	0 0 1	CM	2 0 0 0 0	P	D 0 0 6
b.					
c.					
d.					

J. Additional Descriptions for Materials Listed Above (include physical state and hazard code)

	Haz. Code	Physical State		Haz. Code	Physical State
a.	T	S	Cadmium and Cyanide con & Debris		
b.					

K. Handling Codes for Wastes Listed Above

a.	Landfill	c.	
b.		d.	

15. Special Handling Instructions and Additional Information
WO# 261000
PC# 11551-AAB
EES Buff Job # 312082

16. GENERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations.
If I am a large quantity generator, I certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and that I have selected the practicable method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment; OR, if I am a small quantity generator, I have made a good faith effort to minimize my waste generation and select the best waste management method that is available to me and that I can afford.

Printed/Typed Name	Signature	Month	Day	Year
M. D. Tourdot	[signature]	09	02	87

TRANSPORTER

17. Transporter 1 Acknowledgement of Receipt of Materials

Printed/Typed Name	Signature	Month	Day	Year
KEVIN MAYFIELD	Kevin Mayfield	09	02	87

18. Transporter 2 Acknowledgement of Receipt of Materials

Printed/Typed Name	Signature	Month	Day	Year

FACILITY

19. Discrepancy Indication Space

20. Facility Owner or Operator: Certification of receipt of hazardous materials covered by this manifest except as noted in Item 19.

Printed/Typed Name	Signature	Month	Day	Year

EPA Form 8700-22 (Rev. 9-86) Previous editions are obsolete

COPY 3 – TSD FACILITY: MAIL TO GENERATOR

GENERATOR

In case of accident or spill immediately notify the Pennsylvania Emergency Response Section (717) 787-4343 and the PA DER (717) 787-6842

PAB 4671214

PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL RESOURCES
Bureau of Waste Management
P. O. Box 2063
Harrisburg, PA 17120

Exhibit 2.6

FR-SWM-51:REV. 10/86

Please print or type. (Form designed for use on elite (12-pitch) typewriter.)
Form Approved. OMB No. 2050-0039 Expires 9-30-88

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator's US EPA ID No. P A D 0 0 0 0 0 1 1 1 5 0 0 0 1 — Manifest Document No.

2. Page 1 of

Information in the shaded areas is not required by Federal law but is required by State law.

3. Generator's Name and Mailing Address
Union Switch and Signal
1789 S. Braddock Ave. Pittsburgh, PA. 15218

A. State Manifest Document Number: PAB 4671225

B. State Gen. ID

4. Generator's Phone ( )

5. Transporter 1 Company Name: 7 - 7 Inc.

6. US EPA ID Number: O H D 0 0 0 7 7 2 5 5

C. State Trans. ID: PA-AH

7. Transporter 2 Company Name

8. US EPA ID Number

D. Transporter's Phone (800 221-8096

9. Designated Facility Name and Site Address
Cecos International Inc.
5092 Aber Road
Williamsburg, Ohio 45176

10. US EPA ID Number: O H D 0 8 7 4 3 3 7 4 4

E. State Trans. ID: PA-AH 0 2 3 8

F. Transporter's Phone ( )

G. State Facility's ID: Not Required

H. Facility's Phone (513 724-6114

11. US DOT Description (Including Proper Shipping Name, Hazard Class, and ID Number)	12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol	I. Waste No.
a. Hazardous Waste Solid N.O.S. CRM-E NA 9189 (D-006)	0 0 1	CM	2 0.0 . 0.0	P	D 0. 0
b.					
c.					
d.					

J. Additional Descriptions for Materials Listed Above (include physical state and hazard code)

Haz. Code	Physical State	
a. T	S	Cadmium and Cyanide con & Debris
b.		
c.		
d.		

K. Handling Codes for Wastes Listed Above
a. Landfill
b.
c.
d.

15. Special Handling Instructions and Additional Information
WO# 261001
PC# 11551-AAB
EES Byff Job # 312082

16. GENERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations.
If I am a large quantity generator, I certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and that I have selected the practicable method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment; OR, if I am a small quantity generator, I have made a good faith effort to minimize my waste generation and select the best waste management method that is available to me and that I can afford.

Printed/Typed Name: M. D. Tourdot — Signature: [signature] — Month 09 Day 02 Year 87

TRANSPORTER

17. Transporter 1 Acknowledgement of Receipt of Materials
Printed/Typed Name: Dennis L. Anderson — Signature: [signature] — Month 09 Day 02 Year 87

18. Transporter 2 Acknowledgement of Receipt of Materials
Printed/Typed Name — Signature — Month Day Year

FACILITY

19. Discrepancy Indication Space

20. Facility Owner or Operator: Certification of receipt of hazardous materials covered by this manifest except as noted in item 19.
48.240
Printed/Typed Name: Kent Hoton — Signature: [signature] — Month 09 Day 04 Year 87

EPA Form 8700-22 (Rev. 9-86) Previous editions are obsolete

GENERATOR

In case of an emergency or spill immediately call the National Response Center (800) 424-8802 and the PA DER (717) 787-4343

PAB 4671225

4.1 Procedure for Decommissioning of Storage Facility and Associated Equipment and Labor (continued)

will be used by the environmental coordinator to contain and remove liquids. The final waste inventory will be removed according to the transport operations described earlier in this document.

The environmental coordinator's inspection and inventory will also include an inventory of empty drums. This will encompass the entire facility and will ensure that no drums used for temporary accumulation of hazardous wastes will remain on-site without plans for secure storage and approved ultimate disposal. Drums contained in the facility which previously contained hazardous waste, but are considered "empty, but containing residue" will be collected and stored at the storage area. Empty, decontaminated drums will be checked for requirements of reconditioning and either shipped off-site for reconditioning or crushed prior to proper disposal.

For the purposes of this closure plan, it is assumed that a maximum expected inventory of 80 drums will require shipment at closure. The expected inventory is shown in Table 4. Shipment will occur by the normal procedures described earlier with USSD personnel transporting the drummed wastes from the storage facility to the certified hazardous waste transporter's trucks. There, the environmental coordinator and the transporter will verify that all containers are properly labelled and manifested.

As previously mentioned, Frontier Chemical Inc., 4626 Royal Avenue Niagara Falls, New York has been and is scheduled to be our waste removal hauler. Preparation of the drums will be performed by (2) Union Switch and Signal Division employees.

After the final inventory has been removed, decontamination will commence and be performed by New England Pollution Control Company, (or equivalent),

4.1 Procedure for Decommissioning of Storage Facility and Associated Equipment and Labor (continued)

Route 130 Robbinsville, New Jersey 08691. Decommissioning will consists of a thorough washdown of the concrete floor, ramps, berms, curb and piping with a mild solvent. The washdown will be followed by a pressure wash using a tank truck equipped with solution blower/pressure washer apparatus. An amount of water sufficient to fill the sump will be used to flush any residual wastes, if any, from the concrete floor into the sump. The pressure washing will be supplemented by scrubbing with a stiff broom. Rinseate will be collected in the sump. Visual inspection of the surface of the floor will aid in determining when the decontamination is complete. Rinseate would be discharged to the POTW or on site water treatment plant, as appropriate.

TABLE 4

EXPECTED INVENTORY OF DRUMS

STORAGE FACILITY AT CLOSURE *

ID NUMBER	CHARACTERISTIC	# OF DRUMS	GALLONS
F001	Toxic	5	275
F006	Toxic	6	330
F007	Reactive, toxic	6	330
F008	Reactive, toxic	4	220
F009	Reactive, toxic	4	220
F011	Reactive, toxic	37	1,110
D008	Ep Toxic (Pb)	12	660
D007	Ep Toxic (Cr)	-	-
D001	Ignitable	2	110
D000	Toxic	-	-
D002	Corrosive	2	110
**	Other	2	110
		80	3.475

* If a routine disposal run occurs shortly before closure commenced, it is possible that there will be considerably less than 80 drums on-site .

** "Other" category may include off-spec commercial products such as U002, U188, U228, U239, U159, P106.

4.2 Soil Sampling Program

Soil samples as described by Figure 6 on Page , were taken at 6" and 12" below grade on Juhe 18, 1985 by Marcel D. Tourdot, Manager, Safety, Security and Environment. Lab results indicate that the soil samples would not be classified as EP toxic. Complete results of the lab analyses are included in Appendix A. Follow-up sampling will be done after decommissioning of the storage facility is completed. On the basis of the pre-decommissioning lab data, post decommissioning sampling will be limited to a level 6 inches below the ground surface as described by Figure 7.

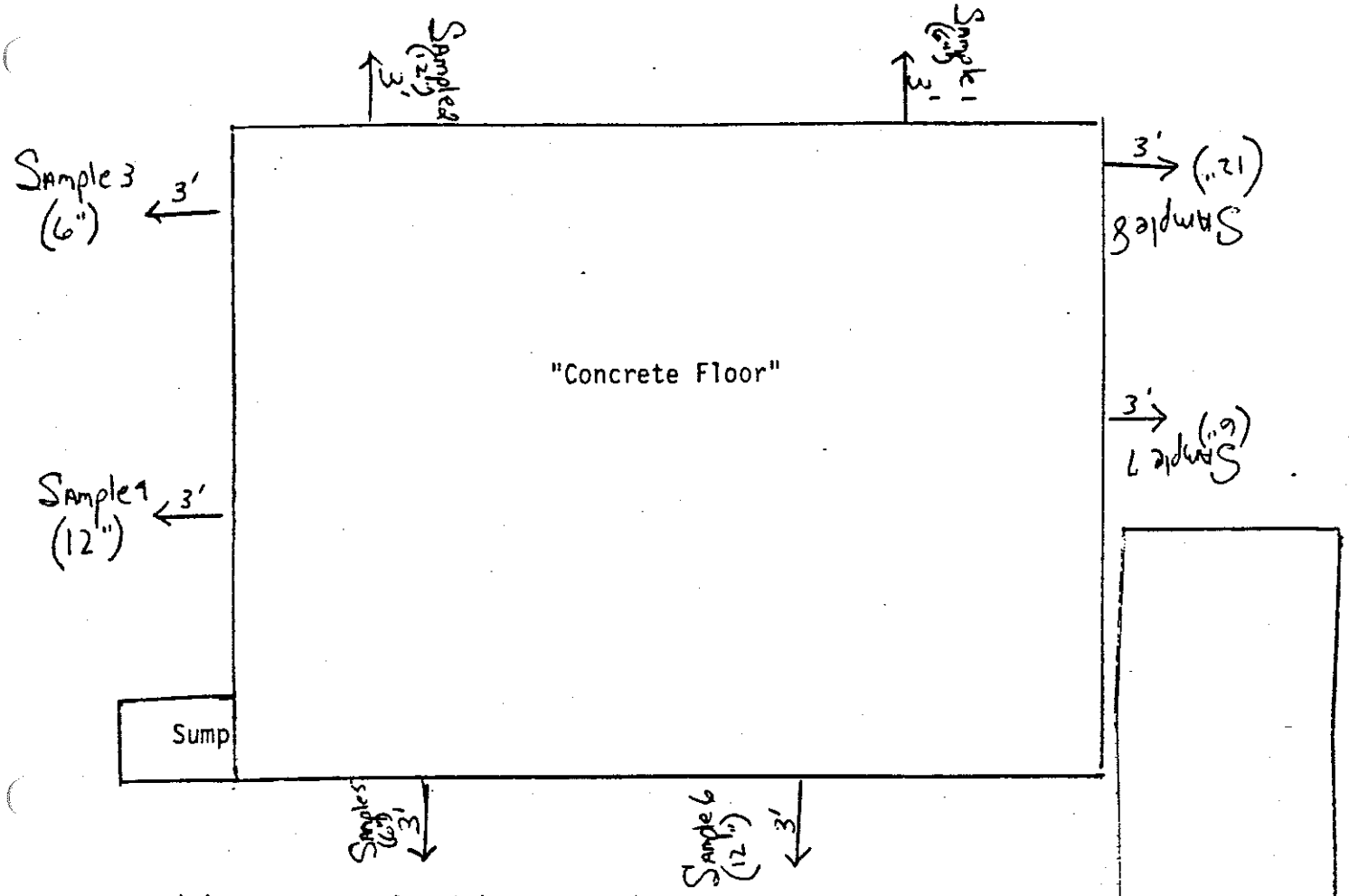
4.3 Closure Schedule

The Pennsylvania Department of Environmental Resources will be notified at least 180 days prior to the date final closure is initiated. If the closure plan receives Pennsylvania Department of Environmental Resources approval prior to the expiration of the prescribed *180 day time period, USSD may initiate closure procedures shortly thereafter.

The closure of the waste storage facility is expected to be completed within 15 weeks after the USSD closure plan is approved by the Pennsylvania Department of Environmental Resources (reference Table 5). A checklist for the closure program is shown in Table 6. Proper certifications of closure procedures are described in the following section of this plan.

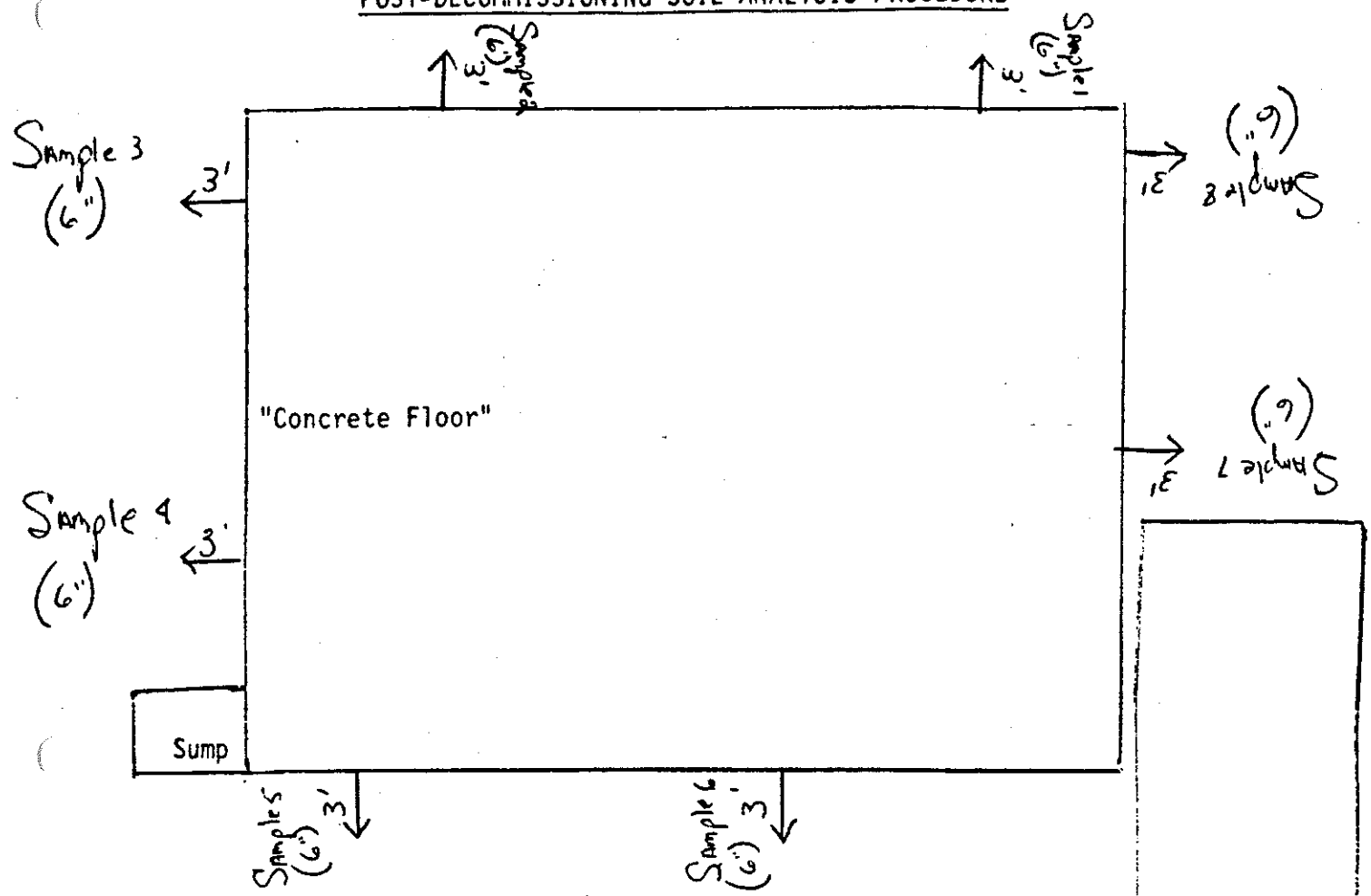
* prescribed by RCRA regulations

FIGURE 6
HAZARDOUS WASTE FACILITY
PRE-DECOMMISSIONING SOIL ANALYSIS PROCEDURE



(1) 8 Grab samples taken
(2) 4 (6") level
(3) 4 (12") level
(4) Samples were mixed and sent to N.U.S. labs as composite sample
(5) Analysis for:
    (A) E. P.Toxicity
    (B) Priority pollutants
    (C) General hydrocarbons
(6) Results in appendix A

FIGURE 7
HAZARDOUS WASTE FACILITY
POST-DECOMMISSIONING SOIL ANALYSIS PROCEDURE



(1) 8 Grab samples taken (6") level

(2) Samples will be mixed and sent to N.U.S. labs as composite sample

(3) Analysis for:

(A) E. P. Toxicity

(B) Priority pollutants

(C) General hydrocarbons

5.0 PROFESSIONAL ENGINEERS CERTIFICATION

At the completion of closure activities, a registered professional engineer licensed in the State of Pennsylvania will inspect the facilities and certify that closure was performed in accordance with the specifications in the closure plan. USSD will submit a similar certification of proper closure (ref. appendix for certification forms to be duly signed and executed at completiion of closure).

A copy of the approved closure plan and all revisions to the plan wil be maintained at Union Switch and Signal Division until the certification of closure completeness has been submitted and accepted by the Pennsylvania Department Environmental Resources.

6.0 CLOSURE COST ESTIMATE

1. Removal of Waste Inventory

A. Shipped for disposal 80 drums @ $100/drum	$8,000
B. Shipped for disposal 5 drums filter cake and associated materials @ $100/drum	500
C. Plant Labor 32 hours @15/hour	480
D. Supervision 16 hours @ $20/hour	320
	$9,300

2. Decommissioning of Storage Facility

A. Treatment of Storage Area Rinsewaters 880 gallons @ $0.20/gallon	200
B. Plant Labor 100 hours @ $15/hour	1,500
C. Supervision 50 hours at $20/hour	1,000
	$2,700

3. Analytical Services

Rinsewater samples, 20 tests @ $20/test	400
Soil Samples 10 tests at 10 parameters per test $40/test	4,000
	$4,400

4. Closure Certification

A. Professional Services (10 hours @ $65/hour)	600
B. Expenses (1 day @ $50/day)	50
C. Transportation	50
	$0,700

5. Subtotal (Items 1-4)	$13,100
A. Administration (10%)	1,400
B. Contingency (10%)	1,400
6. TOTAL CLOSURE COST	$19,900

TABLE 5
CLOSURE TIME SCHEDULE
WEEK NUMBER

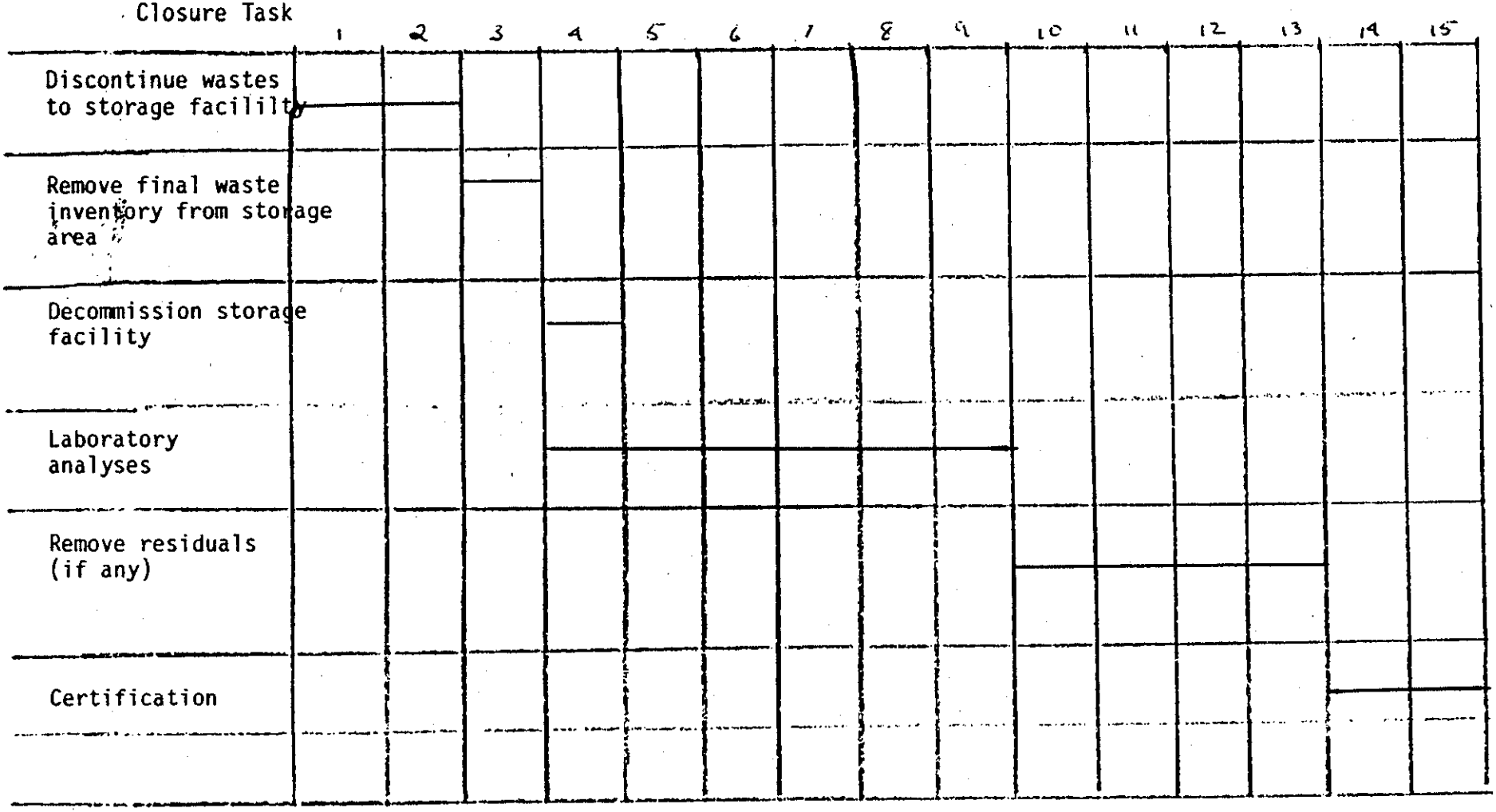


TABLE 6

4.3.1 Checklist for Program Completion

	YES/DATE	NO
1. 180 day notice to Pennsylvania Department of Environmental Resources		
2. Submittal of Closure Plan		
3. Certification of Proper Closure: USSD PE		
4. Acceptance of last incoming waste		
5. Waste inventory reconciliation (See Exhibit for working field copy)		
6. Confirm integrity of drums for preparation for shipment		
7. Inspect spills, leaks, cracks in containment area		
8. Soil analysis as appropriate		
9. Waste removal		
10. Decommissioning of area and equipment		
11. Final inspection of area		

APPENDICES

A. Lab Results per Nus Corporation

B. Closure Completion Certification Form

NUS CORPORATION

Laboratory Services Division
5350 Campbells Run Road
Pittsburgh, PA 15205

REMIT TO:
Park West Two
Cliff Mine Road
Pittsburgh, PA 15275
412-788-1080

L A B A N A L Y S I S R E P O R T

CLIENT NAME: UNION SWITCH & SIGNAL DIVISION
ADDRESS: 1789 BRADDOCK AVENUE
SWISSVALE, PA 15218
REPORT DATE: 08/01/85
ATTENTION: MR. AL SPROUL

NUS CLIENT NO: 360501
NUS SAMPLE NO: 15051618
VENDOR NO: 05765200
WORK ORDER NO: 55830
DATE RECEIVED: 05/21/85

SAMPLE IDENTIFICATION: SAMPLE #4 - PAD 05/13 AS REC'D

TEST	DETERMINATION	RESULTS	UNITS
P135	BASE NEUTRALS - PP IN SEDIMENT		
OB51	Acenaphthene	< 1480	ug/kg
OB52	Acenaphthylene	< 1480	ug/kg
OB53	Anthracene	< 1480	ug/kg
OB54	Benzidine	< 7400	ug/kg
OB55	Benzo(a)Anthracene	< 1480	ug/kg
OB56	Benzo(a)Pyrene	< 1480	ug/kg
OB57	3,4-Benzofluoranthene	< 1480	ug/kg
OB58	Benzo(ghi)Perylene	< 1480	ug/kg
OB59	Benzo(k)Fluoranthene	< 1480	ug/kg
OB60	Bis(2-Chloroethoxy)Methane	< 1480	ug/kg
OB61	Bis(2-Chloroethyl)Ether	< 1480	ug/kg
OB62	Bis(2-Chloroisopropyl)Ether	< 1480	ug/kg
OB63	Bis(2-Ethylhexyl)Phthalate	< 1480	ug/kg
OB64	4-Bromophenyl Phenyl Ether	< 1480	ug/kg
OB65	Butyl Benzyl Phthalate	< 1480	ug/kg
OB66	2-Chloronaphthalene	< 1480	ug/kg
OB67	4-Chlorophenyl Phenyl Ether	< 1480	ug/kg
OB68	Chrysene	< 1480	ug/kg
OB69	Dibenzo(a,h)Anthracene	< 1480	ug/kg
OB70	1,2-Dichlorobenzene	< 1480	ug/kg
OB71	1,3-Dichlorobenzene	< 1480	ug/kg
OB72	1,4-Dichlorobenzene	< 1480	ug/kg
OB73	3,3'-Dichlorobenzidine	< 2960	ug/kg
OB74	Diethyl Phthalate	< 1480	ug/kg
OB75	Dimethyl Phthalate	< 1480	ug/kg
OB76	Di-N-Butyl Phthalate	< 1480	ug/kg
OB77	2,4-Dinitrotoluene	< 1480	ug/kg
OB78	2,6-Dinitrotoluene	< 1480	ug/kg
OB79	Di-N-Octyl Phthalate	< 1480	ug/kg
OB80	1,2-Diphenylhydrazine(Azobz)	< 2960	ug/kg
OB81	Fluoranthene	< 1480	ug/kg
OB82	Fluorene	< 1480	ug/kg
OB83	Hexachlorobenzene	< 1480	ug/kg

NUS CORPORATION

Laboratory Services Division
5350 Campbells Run Road
Pittsburgh, PA 15205

REMIT TO:
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Cliff Mine Road
Pittsburgh, PA 15275
412-788-1080

LAB ANALYSIS REPORT

CLIENT NAME: UNION SWITCH & SIGNAL DIVISION
ADDRESS: 1789 BRADDOCK AVENUE
SWISSVALE, PA 15218
REPORT DATE: 08/01/85
ATTENTION: MR AL SPROUL

NUS CLIENT NO: 360501
NUS SAMPLE NO: 15051618
VENDOR NO: 05765200
WORK ORDER NO: 55830
DATE RECEIVED: 05/21/85

SAMPLE IDENTIFICATION: SAMPLE #4 - PAD 05/13 AS REC'D

TEST	DETERMINATION	RESULTS	UNITS
OB84	Hexachlorobutadiene	< 1480	ug/kg
OB85	Hexachlorocyclopentadiene	< 1480	ug/kg
OB86	Hexachloroethane	< 1480	ug/kg
OB87	Indeno(1,2,3cd) Pyrene	< 1480	ug/kg
OB88	Isophorone	< 1480	ug/kg
OB89	Naphthalene	< 1480	ug/kg
OB90	Nitrobenzene	< 1480	ug/kg
OB91	N-Nitrosodimethylamine	< 1480	ug/kg
OB92	N-Nitrosodi-N-Propylamine	< 1480	ug/kg
OB93	N-Nitrosodiphenylmine	< 1480	ug/kg
OB94	Phenanthrene	< 1480	ug/kg
OB95	Pyrene	< 1480	ug/kg
OB96	1,2,4-Trichlorobenzene	< 1480	ug/kg

NUS CORPORATION

Laboratory Services Division
5350 Campbells Run Road
Pittsburgh, PA 15205

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Pittsburgh, PA 15275
412-788-1080

LAB ANALYSIS REPORT

CLIENT NAME: UNION SWITCH & SIGNAL DIVISION
ADDRESS: 1789 BRADDOCK AVENUE
SWISSVALE, PA 15218
REPORT DATE: 08/01/85
ATTENTION: MR AL SPROUL

NUS CLIENT NO: 360501
NUS SAMPLE NO: 15051619
VENDOR NO: 05765200
WORK ORDER NO: 55830
DATE RECEIVED: 05/21/85

SAMPLE IDENTIFICATION: SAMPLE #4 - PAD 05/13 AS REC'D

TEST	DETERMINATION	RESULTS	UNITS
0115	VOLATILES-PP IN SEDIMENT		
OV41	Acrolein	< 10000	ug/kg
OV42	Acrylonitrile	< 10000	ug/kg
OV43	Benzene	560	ug/kg
OV45	Bromoform	< 500	ug/kg
OV46	Carbon Tetrachloride	< 500	ug/kg
OV47	Chlorobenzene	< 500	ug/kg
OV48	Chlorodibromomethane	< 500	ug/kg
OV49	Chloroethane	< 1000	ug/kg
OV50	2-Chloroethylvinyl Ether	< 1000	ug/kg
OV51	Chloroform	< 500	ug/kg
OV52	Dichlorobromomethane	< 500	ug/kg
OV54	1,1-Dichloroethane	< 500	ug/kg
OV55	1,2-Dichloroethane	< 500	ug/kg
OV56	1,1-Dichloroethylene	< 500	ug/kg
OV57	1,2-Dichloropropane	< 500	ug/kg
OV58	1,3-Dichloropropylene	< 500	ug/kg
OV59	Ethylbenzene	< 500	ug/kg
OV60	Methyl Bromide	< 1000	ug/kg
OV61	Methyl Chloride	< 1000	ug/kg
OV62	Methylene Chloride	< 500	ug/kg
OV63	1,1,2,2-Tetrachloroethane	< 500	ug/kg
OV64	Tetrachloroethylene(Perchloro)	< 500	ug/kg
OV65	Toluene	< 500	ug/kg
OV66	1,2-Trans-Dichloroethylene	< 500	ug/kg
OV67	1,1,1-Trichloroethane	< 500	ug/kg
OV68	1,1,2-Trichloroethane	< 500	ug/kg
OV69	Trichloroethylene	< 500	ug/kg
OV70	Trichlorofluoromethane	< 500	ug/kg
OV71	Vinyl Chloride	< 1000	ug/kg

NUS CORPORATION

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NUS CLIENT NO: 360501
NUS SAMPLE NO: 15051618
VENDOR NO: 05765200
WORK ORDER NO: 55830
DATE RECEIVED: 05/21/85

SAMPLE IDENTIFICATION: SAMPLE #4 - PAD - 05/13 AS REC'D

TEST	DETERMINATION	RESULTS	UNITS
0125	ACIDS - PP IN SEDIMENT		
OA21	2-Chlorophenol	< 1480	ug/kg
OA22	2,4-Dichlorophenol	< 1480	ug/kg
OA23	2,4-Dimethylphenol	< 1480	ug/kg
OA24	4,6-Dinitro-o-cresol	< 7400	ug/kg
OA25	2,4-Dinitrophenol	< 7400	ug/kg
OA26	2-Nitrophenol	< 1480	ug/kg
OA27	4-Nitrophenol	< 7400	ug/kg
OA28	p-Chloro-a-cresol	< 1480	ug/kg
OA29	Pentachlorophenol	< 7400	ug/kg
OA30	Phenol	< 1480	ug/kg
OA31	2,4,6-Trichlorophenol	< 1480	ug/kg
OE22	LLS - Extraction		

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REPORT DATE 08/01/85
ATTENTION MR AL SPROUL

NUS CLIENT NO 360501
NUS SAMPLE NO 15051618
VENDOR NO 05765200
WORK ORDER NO 55830
DATE RECEIVED 05/21/85

SAMPLE IDENTIFICATION: SAMPLE #4 - PAD 05/13 AS REC'D

TEST	DETERMINATION	RESULTS	UNITS
OM98	Hydrocarbon GC Scan	< 10	mg/kg

Form G-1 4/78

CONFIDENTIAL

MATERIAL SAFETY DATA SHEET

• Section 1 – PRODUCT IDENTIFICATION

MANUFACTURER'S NAME
DEARBORN CHEMICAL (U.S.), CHEMED CORPORATION

EMERGENCY PHONE NO.
312/438-8241

ADDRESS
300 Genesee St., Lake Zurich, IL 60047

CHEMICAL NAME AND SYNONYMS
Potable and process water treatment

TRADE NAME OR CODE IDENT.
AQUAFLOC® 408

• Section 2 – INGREDIENTS

	CAS No.	%	EXPOSURE CRITERIA

NON-HAZARDOUS MATERIAL

The product identified in this Data Sheet is NOT a hazardous material within the meaning of Title 29, Code of Federal Regulations 1915, 1916, 1917.

• Section 3 – PHYSICAL DATA

BOILING POINT, 760mm Hg	approx. 212° F.	MELTING POINT	
SPECIFIC GRAVITY (H_2O = 1)	1.02	VAPOR PRESSURE	
VAPOR DENSITY (AIR = 1)		SOLUBILITY IN H_2O, % BY WT.	Moderate
VOLATILES BY VOLUME		EVAPORATION RATE, _____ = 1	
APPEARANCE AND ODOR	Clear liquid with no specific odor	pH	4.0

• Section 4 – FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (and Method Used)	FLAMMABLE LIMITS in AIR, % by VOLUME LOWER / UPPER	AUTO IGNITION TEMPERATURE
None		

EXTINGUISHING MEDIA ☐ Water Fog ☐ Foam ☐ CO_2 ☐ Dry Chemical ☐ Other

SPECIAL FIRE FIGHTING PROCEDURES

UNUSUAL FIRE AND EXPLOSION HAZARD

• Section 5 – REACTIVITY DATA

STABILITY (Normal Conditions)	CONDITIONS TO AVOID
☒ Stable ☐ Unstable	

INCOMPATIBILITY (Materials to Avoid)

HAZARDOUS DECOMPOSITION PRODUCTS

HAZARDOUS POLYMERIZATION	CONDITIONS TO AVOID
☐ May Occur ☒ Will Not Occur	

(over)

EXPOSURE LIMIT

Not established

EFFECTS OF OVEREXPOSURE

INHALATION

INGESTION

If ingested, administer emetic or drink large amounts of milk or water to neutralize.

SKIN OR EYE CONTACT

Material has acid pH between 4 and 5. Wash from skin with plenty of water. If splashed in eyes, flush with large amounts of water, consult a physician.

EMERGENCY AND FIRST AID PROCEDURES

• Section 7 – SPECIAL PROTECTION INFORMATION

VENTILATION REQUIREMENTS

Mechanical exhaust is adequate.

RESPIRATORY PROTECTION (Specify Type)

EYE PROTECTION	GLOVES (Specify Type)
Goggles or face shield	Rubber or plastic

OTHER PROTECTIVE CLOTHING AND EQUIPMENT (Specify Type)

• Section 8 SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED

Use industrial absorbent, wash residue to drain. Dispose using chemical scavenger service.

WASTE DISPOSAL METHOD

Approved chemical scavenger service. Destroy drums.

• Section 9 – SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE

Protect from freezing. Freeze point, approx. 32° F.

OTHER PRECAUTIONS

Shelf life approx. one year.

Shipping Name: DOT NOT RESTRICTED Compound Water Clarifying, Not Medicated or Perfumed, Liqui

IATA

Prepared By W. M. Morris

Date: 8/78

Allied Chemical

CHEMICALS COMPANY

PRODUCT SAFETY DATA SHEET

A. GENERAL INFORMATION

TRADE NAME (COMMON NAME OR SYNONYM)
PHOSPHORIC ACID META, Chip

☐ C.A.S. NO. ☒ ALLIED PRODUCT CODE #
108-001147

CHEMICAL NAME
Phosphoric Acid, Meta; Metaphosphoric Acid

FORMULA
$(HPO_3)_n$

MOLECULAR WEIGHT
Unknown

COMPANY/PLANT ADDRESS (No., STREET, CITY, STATE AND ZIP CODE)
CHEMICALS COMPANY
POB 1139R
Morristown, N.J. 07960

CONTACT	PHONE NUMBER	ISSUED DATE	REVISED DATE
Director, Product Safety	(201) 455-4157	Nov., 1975	Aug., 1980

B. FIRST AID MEASURES

EMERGENCY PHONE NUMBER
(201) 455-2000

Skin and eyes: immediately wash thoroughly with water.
Eyes: call a physician.
Inhalation: remove to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. Get Medical help.
Ingestion: immediately drink large quantities of water or milk, repeating if vomiting.** Aim to dilute acid 100 times approximately. Call a physician.
**However, do not induce vomiting.

C. HAZARDS INFORMATION

FIRE AND EXPLOSION

FLASH POINT (☐ OPEN CUP ☐ CLOSED CUP)	AUTO IGNITION TEMPERATURE	FLAMMABLE LIMITS IN AIR (% BY VOL.)
N.A. °C (not combustible)	N.A. °C	LOWER N.A. UPPER

UNUSUAL FIRE AND EXPLOSION HAZARDS
If reacting with metals, Section G, it releases hydrogen, which is flammable and explosive.

HEALTH

INHALATION
Dust or mist or vapor from material (at high temperatures) will irritate upper respiratory tract and may cause lung damage.

INGESTION
May irritate or may burn digestive tract.

SKIN
Gross contact with dust or solution: will destroy body tissues and cause severe burns.
Mist: will irritate.

EYES
Gross contact with dust or solution: will destroy body tissues and cause severe burns.
Mist: will irritate.

PERMISSIBLE CONCENTRATION: AIR (SEE SECTION J) None appears to be established. In the absence of an established standard, the figure of 1 mg/m^3, which is valid for ortho-phosphoric acid, may be a safe guideline. TLV: none appears to be established. BIOLOGICAL None established.

SUAL CHRONIC TOXICITY
Unknown.

C 2021 (10-78)

D. PRECAUTIONS/PROCEDURES

VENTILATION

Local exhaust: in the vicinity of acid mist or dust or vapor (from material at high temperatures).

Mechanical (general): adequate in other situations.

Equipment should be corrosion-proof.

NORMAL HANDLING

Do not get in eyes, on skin, on clothing. Avoid breathing vapor or mist. Keep container tightly closed and upright. Use with adequate ventilation.

STORAGE

Protect against physical damage. (1) Before moving drum, be sure closures are securely fastened; (2) Store out of sun and away from heat in well-ventilated location of low fire risk; (3) Keep upright. Do not reuse drum.

PRECAUTIONARY LABEL ☐ ATTACHED ☒ NOT ATTACHED DOT Classification: Not Regulated.

Allied Chemical label 108-001147-D-80 has been approved for this service. DANGER! CAN CAUSE BURNS. CAUSES IRRITATION. HARMFUL IF SWALLOWED.

SPILL OR LEAK

In case of spill: Neutralize small spills carefully with sodium carbonate and flush to sewer with authority approval. If large spill: Dike the area and collect in metal containers, avoiding prolonged skin contact. Close containers and provide suitable labeling. Ventilate to remove any carbon dioxide emitted as a result of neutralizing.

FIRE EXTINGUISHING AGENTS RECOMMENDED

If involved in a fire, use water.

SPECIAL FIRE FIGHTING PRECAUTIONS

Wear self-contained breathing apparatus; wear goggles if eye protection is not provided. Use water to keep exposed containers cool. Water spray may be used to flush spills away from exposures.

FIRE EXTINGUISHING AGENTS TO AVOID

No standard agent.

SPECIAL PRECAUTIONS/PROCEDURES

Because of its unusual physical properties as a solid, yet a potentially strong acid, special personnel training is advisable.

E. PERSONAL PROTECTIVE EQUIPMENT

RESPIRATORY PROTECTION Against dust or mist up to 50 mg/m^3: high-efficiency particulate respirator with a full facepiece or supplied-air respirator with a full facepiece or self-contained breathing apparatus. Against dust, mist, or vapor up to 2000 mg/m^3: supplied-air respirator, Type C, with a full facepiece operated in pressure-demand or other positive pressure mode or with a full facepiece, helmet, or hood operated in continuous-flow mode.

EYES AND FACE

Goggles if there is any possibility of contact with dust, mist, or solution.

HANDS, ARMS, AND BODY

Protective clothing if there is any possibility of contact with solutions stronger than 1.6% or if there is reasonable probability of contact with solutions weaker than 1.6%. Remove immediately any contaminated non-impervious clothing. Change after work any impervious clothing contaminated with solution.

OTHER CLOTHING AND EQUIPMENT

Provide eyewash and quick-drench facilities in areas where solutions stronger than 1.6% are being handled or stored. Protective boots and hats when working with solutions requiring protective clothing.

F. PHYSICAL DATA

MATERIAL IS (AT NORMAL CONDITIONS):	APPEARANCE AND ODOR	
☐ LIQUID ☒ SOLID ☐ GAS ☐ _____	Clear, colorless, crystals, deliquescent; odorless. 14-gal. drum.	
BOILING POINT N.A. °C (sublimes at red heat) MELTING POINT N.A. (glassy) °C	SPECIFIC GRAVITY (H_2O = 1) (solid) 2.2 to 2.5	VAPOR DENSITY (AIR = 1) Unknown. (heavier than air)
SOLUBILITY IN WATER (% by weight) In water, slowly forms ortho-phosphoric acid, which is soluble up to 88%.	PH For the ortho-acid: 1.5 (0.1N aqueous)	VAPOR PRESSURE (mm Hg at 20° C) Approx. 0.03 (Estimated as equal to the ortho-acid
EVAPORATION RATE (Butyl Acetate = 1) Negligible @ ambient.	% VOLATILES BY VOLUME (At 20° C) Negligible @ ambient.	

G. REACTIVITY DATA

STABILITY	CONDITIONS TO AVOID
☐ UNSTABLE ☒ STABLE	Pure and solid sublimes @ red heat. Aqueous solutions form acid mist on boiling.

INCOMPATIBILITY (MATERIALS TO AVOID)

If melted or dissolved in water, will attack most metals. Alkalis and metallic oxides, carbonates, sulfides, and cyanides.

HAZARDOUS DECOMPOSITION PRODUCTS

Misting, as above, on boiling aqueous solutions.

HAZARDOUS POLYMERIZATION	CONDITIONS TO AVOID
☐ MAY OCCUR ☒ WILL NOT OCCUR	N.A.

H. HAZARDOUS INGREDIENTS (Mixtures Only) N.A.

MATERIAL OR COMPONENT	%	HAZARD DATA (SEE SECT. J)

ENVIRONMENTAL

BIODEGRADABILITY	OCTANOL/WATER PARTITION COEFFICIENT
N.A. (inorganic)	Unknown.

WASTE DISPOSAL METHODS*

Disposal of Phosphoric Acid, Meta, Chip may be subject to federal, state, and local regulations. Users of this product should review their operations in terms of applicable federal, state, and local laws and regulations, then consult with appropriate regulatory agencies before discharging or disposing of waste material.

*DISPOSER MUST COMPLY WITH FEDERAL, STATE AND LOCAL DISPOSAL OR DISCHARGE LAWS.

REFERENCES

PERMISSIBLE CONCENTRATION REFERENCES

OSHA Regulations, 29 CFR 1910.1000, as extended, see Section C.

REGULATORY STANDARDS

DOT Classification: Allied Chemical Corporation.
Designated a hazardous substance for spills by EPA (40 CFR, Parts 116-117).

GENERAL

(a) NIOSH/OSHA, "Pocket Guide to Chemical Hazards," 1978.
(b) NFPA Manual 49, "Hazardous Chemicals Data," 1975.

ADDITIONAL INFORMATION

MATERIAL SAFETY DATA SHEET

"ESSENTIALLY SIMILAR" TO OSHA FORM 20

FORM 4040 (Rev. 9-80)

PENNWALT CORPORATION

ADDRESS: Pennwalt Corporation
Three Parkway
Philadelphia, PA 19102

IDENTIFICATION

Pennwalt Product Name: Caustic Soda, 50% Standard Grade (Aqueous)

Pennwalt Code No.: 0209

Chemical Name and Molecular Formula: Sodium Hydroxide NaOH

Emergency Phone Number(s)
Hrs. Business: 215-587-7695
Other: 313-285-9200
502-395-7121

Synonyms: Caustic Soda, Liquid Caustic Soda

CAS No.(s): 1310-73-2

Chemical Family: Alkali

INGREDIENTS

MATERIALS OR COMPONENTS	% w/w	HAZARD DATA (TLV, LD50, LC50, etc.)
Sodium Hydroxide	50	orl-rbt: LDLo: 500 mg/kg Corrosive Liquid See Toxicity Section

TRANSPORTATION DATA

T/T: RQ Caustic Soda, Solution; Corrosive Material; UN 1824 Corrosive Placards.

T/C: RQ Caustic Soda, Solution; Corrosive Materia; UN 1824 Placarded Corrosive; STCC 4935240

PHYSICAL PROPERTIES

Boiling Point/Range: 142 °C 288 °F	Melting Point: - °C - °F	Freezing Point: 12 °C 54 °F	Molecular Weight (Calculated): 40.01
Specific Gravity (H_2O=1): 1.525 @ / 20 °C	Vapor Pressure (mm Hg): 1.6 @ 20 °C 68 °F	Vapor Density (Air=1):	
Solubility in H_2O: 100%	% Volatiles by Volume: Non-Volatile	Evaporation Rate: ☐ Ether = 1 ☐ Water = 1 ☐ Butylacetate = 1	
Appearance and Odor: Water white, clear to slightly trubid liquid.		Other:	

Flash Point: None °C °F	Test Method: Non-combustible	Flammable Limits: Lower % None Upper %	Autoignition Temperature/Fire Point: °C None °F

EXTINGUISHING MEDIA
☐ Water-spray ☐ Water-fog ☐ Water stream ☐ CO_2 ☐ Dry chemical ☐ Alcohol foam ☐ Foam ☐ Earth or sand

SPECIAL FIRE FIGHTING PROCEDURES
☐ Do not enter building ☐ Allow fire to burn ☐ Water may cause frothing ☐ Do not use water

UNUSUAL FIRE AND EXPLOSION HAZARDS
☐ Dust explosion hazard ☐ Sensitive to shock ☐ Contamination ☐ Temperature ☐ Other (specify):

STABILITY
☒ Stable ☐ Unstable

CONDITIONS CONTRIBUTING TO INSTABILITY
☐ Thermal decomposition ☐ Photo degradation ☐ Polymerization ☐ Contamination

INCOMPATIBILITY - Avoid contact with
☒ Strong acids ☐ Strong alkalis ☒ Other: Can react violently or explosively with some chemicals such as chlorinated hydrocarbons and organic acids. Hazardous carbon monixide gas can form upon contact with food and beverage products in enclosed spaces and can cause death. Follow appropriate tank entry procedures (See ANSI Z117.1-1977).

HAZARDOUS DECOMPOSITION PRODUCTS - THERMAL AND OTHER (list)

CONDITIONS TO AVOID
☐ Heat ☐ Open flames ☐ Sparks ☐ Ignition sources ☐ Other (specify):

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED
☒ Flush with water ☐ Absorb with sand or inert material ☒ Neutralize ☐ Sweep or scoop up and remove ☐ Keep upwind. Evacuate enclosed spaces. ☐ Prevent spread or spill
☐ Dispose of immediately ☐ Other (specify):

WASTE DISPOSAL METHOD - *Consult federal, state, or local authorities for proper disposal procedures.*
Dilute with water then neutralize with acid.

CONTINUED ON REVERSE SIDE ▶

9/25/81

Not Applicable.

Other (acute): Causes severe burns of the mucous membranes of the mouth, throat, esophagus and stomach.

Dermal (acute): Corrosive burns to all body tissue in contact.

Eye: Causes very rapid severe damage.

Inhalation (acute): May vary from mild irritation of nasal mucous membranes to severe pneumonitis.

Chronic, Subchronic, etc.: May consist of multiple areas of superficial destruction of the skin or of primary irritant dermatitis, similarily, inhalation of the mist may result in varying degress of irritation of the respiratory tract tissues.

TOXICITY

Effects of Exposure

PERMISSIBLE EXPOSURE LIMIT (Specify if TLV/TWA or Ceiling [c])

ACGIH 1981 TLV 2mg/m3 (air) | OSHA 1981 TWA 2mg/m3 (air) | Other: These are ceiling limits.

IRRITATION: [ ] Skin [ ] Eye — [ ] Severe [ ] Severe — [ ] Moderate [ ] Moderate — [ ] Mild (transient)

CORROSIVITY: [X] Skin [X] Eye — [ ] 4 hrs. (DOT) [X] May cause blindness — [ ] 24 hrs. (CPSC)

SENSITIZATION: [ ] Skin [ ] Respiratory [ ] Allergen

INHALATION EFFECTS: [ ] Narcotic effect [ ] Cyanosis [ ] Asphyxiant

LUNG EFFECTS (Specify): Inhalation of mist may cause damage to upper respiratory tract and even to lung tissue proper.

OTHER (Specify): [ ] Repeated contact - skin defatter [ ] Other (Specify):

Emergency / First Aid

INGESTION: [ ] Induce vomiting [X] Do NOT induce vomiting [X] Give plenty of water [X] Get medical attention [X] Other (specify): Drink large quantities of milk, follow with dilute vinegar or fruit juice.

DERMAL: [X] Flush with soap and water [X] Get medical attention [ ] Contaminated clothing - remove & launder [ ] Contaminated shoes - destroy [ ] Other (specify):

EYE CONTACT: [X] Flush with plenty of water for at least 15 minutes [X] Get medical attention [ ] Other (specify):

INHALATION: [X] Remove to fresh air [ ] If not breathing, give artificial respiration [ ] Give oxygen [X] Get medical attention [ ] Other (specify):

SPECIAL PROTECTION INFORMATION

VENTILATION REQUIREMENTS — *Always maintain exposure below permissible exposure limits*

[ ] Consult an industrial hygienist or environmental health specialist [ ] Local exhaust [X] Use with adequate ventilation [ ] Check for air contaminant and oxygen deficiency

[ ] Other (specify): For proper tank entry procedures, see ANSI Z117.1-1977. Monitor carbon monoxide and oxygen levels in tanks and enclosed spaces.

EYE: [ ] Safety glasses [X] Face shield [X] Goggles

HAND (GLOVE TYPE): [X] Polyvinyl chloride [X] Neoprene [X] Butyl rubber [X] Natural rubber [ ] Polyvinyl alcohol [ ] Poly-ethylene [ ] Other (specify):

RESPIRATOR TYPE - *Use only NIOSH / MESA approved equipment*

[ ] Self-contained [ ] Supplied air [ ] Can or cartridge gas or vapor [X] Filter - dust, fume, mist [ ] Other (specify):

OTHER PROTECTIVE EQUIPMENT: [ ] Rubber boots [ ] Apron [X] Other (specify): Rubber boots, cotton work clothes, rubber suit or apron, if necessary.

SPECIAL PRECAUTIONS

PRECAUTIONARY LABELING

[X] Wash thoroughly after handling [X] Do not get in eyes, on skin or clothing [X] Do not breathe dust, vapor, mist, gas [X] Keep container closed [ ] Keep away from heat, sparks, and open flames [X] Store in tightly closed containers

[ ] Do not store near combustibles [ ] Keep from contact with clothing and other combustible materials [X] Empty container may contain hazardous residues [ ] Use explosion proof equipment [ ] Other (specify):

Other handling and storage conditions: Safety showers and eye wash fountains should be installed in any area where NaOH is handled.

by	Date	Address	Phone
James E. Pike	9/25/81	3 Parkway, Phila., PA 19102	215-587-7695

Procedures for Process Plant Shut Down

Empty Rinse Tanks - Through Rinse Water Waste Treatment Units
Empty Some Process Tanks Through Rinse Water Waste Treatment Unit

Rate of emptying controlled by ability of Rinse Water Waste Treatment Facility. Requires coordination between Waste Treatment operator and clean-up crew.

1. Clean-up crew to start transferring the process baths to the Rinse Water Waste Treatment Unit at a slow rate.
2. If Waste Treatment process can not keep up (Feed the necessary chemicals fast enough), shut down transfer until RWWTF can catch up.
3. Start feeding again at a slower rate. Repeat until a rate is established that the RWWTF can handle.
4. If the RWWTF can handle the initial flow, slowly increase the rate of waste discharge until the treatment system reaches its limit. At this point, slow the waste flow down a smaller amount to insure that the system is able to keep up.

General Comments

1. Check chemical feed supplies and be sure that you do not run out. Try to order in plenty of time to insure an adequate supply.
2. Check pump equipment daily.
3. Check instrument calibration daily.
4. Check coagulation process two or three times daily.
5. Keep good records daily.
6. Keep your work area and lab area clean and orderly.
7. Check supplies of laboratory chemicals weekly. Order replacements as needed.

ARITHMETIC OF TREATMENT

Basic Units

Linear	1 inch (in.)	= 2.540 centimeters (cm)
	1 foot (ft.)	= 12 inches (in.)
	1 yard (yd.)	= 3 feet (ft.)
	1 mile	= 5,280 feet
	1 meter (m)	= 39.37 in. = 3.281 ft. = 1.094 yd.
	1 meter	= 100 centimeters
Area	1 square foot (sq. ft.)	= 144 square inches (sq. in.)
	1 square yard (sq. yd.)	= 9 sq. ft.
	1 acre	= 43,560 sq. ft.
	1 square mile	= 640 acres
Volume	1 cubic foot	= 1728 cubic inches (cu. in.)
	1 cubic yard	= 27 cu. ft.
	1 cubic foot	= 7.48 gallons
	1 gallon (gal.)	= 231 cu. in.
	1 gallon	= 4 quarts (qt)
	1 gallon	= 3.785 liters (l)
	1 liter	= 1000 milliliters (ml)
Weight	1 pound (lb.)	= 16 ounces = 7000 grains = 453.6 grams
	1 ounce	= 28.35 grams (g)
	1 kilogram	= 1000 grams
	1 gram	= 1000 milligrams (mg)
	1 cu. ft. water	= 62.4 pounds
	1 gallon water	= 8.33 pounds
	1 liter water	= 1 kilogram
	1 milliliter water	= 1 gram

Definition of Terms

A *ratio* is the indicated division of two pure numbers. As such is indicates the relative magnitude of two quantities. The ratio of 2 to 3 is written 2/3.

A *pure* number is used without reference to any particular thing.

A *concrete* number applies to a particular thing and is the product of a pure number and a physical unit. 5 ft. means 5 times 1 ft. or 5 × (1 ft.).

Parts per million:

This is a weight ratio. Any unit may be used; pounds per million pounds or milligrams per liter if the liquid has a specific gravity equal to water or very nearly so. 1 liter of water = 1,000,000 milligrams.

1 ppm = 8.33 lbs. per million gallons

1 ppm = 1 milligram per liter

A sewage with 600 ppm suspended solids has 600 × 8.33 = 4998 lb. of suspended solids per million gallons.

Efficiency of Removal:

$$\frac{\text{ppm influent} - \text{ppm effluent}}{\text{ppm influent}} 100 = \text{per cent efficiency of removal}$$

Percent of Moisture:

$$\frac{\text{wt. of wet sludge} - \text{wt. of dry sludge}}{\text{wt. of wet sludge}} 100 = \text{per cent moisture}$$

Percent of Dry solids:

$$\frac{\text{wt. of dry sludge}}{\text{wt. of wet sludge}} 100 = \text{per cent dry solids}$$

Other calculated quantities that need no special explanation are:
Square feet of sludge drying bed per capita
Cubic feet of digestion space per capita
Cubic feet of sludge produced per day per capita
Cubic feet of grit per million gallons
Pounds of sludge per capita per day
Cubic feet of gas per capita per day
Kilowatt-hours per million gallons pumped

Specific Gravity: This is the ratio of the density of a substance to the density of water. There is no unit. Density = the weight of unit volume.

$$\text{S.G.} = \frac{(\text{wt. bottle with sludge}) - (\text{wt. of empty bottle})}{(\text{wt. bottle with water}) - (\text{wt. of empty bottle})}$$

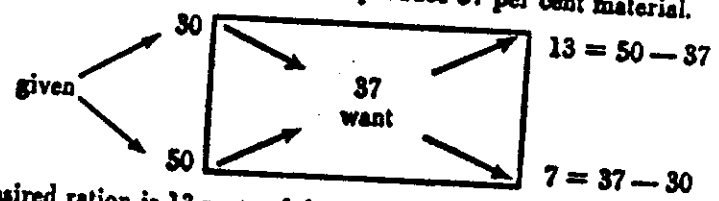
1 gallon of water = 8.33 lbs.
1 cu. ft. of water = 62.4 lbs.
These vary slightly with temperature.
Water at 32°F. = 62.417 lb./ft.^{3}
Water at 62°F. = 62.355 lb./ft.^{3}
Water at 212°F. = 59.7 lb./ft.^{3}
Ice = 57.5 lb./ft.^{3}

Problem: What is the weight of dry solids in 1000 gallons of 10% sludge whose specific gravity is 1.04?

$$1000 \times 8.33 \times 1.04 \times \frac{10}{100} = 866.3 \text{ lbs.}$$

Mixtures:

If two materials of different percentages are to be mixed to produce an intermediate percentage, it may be done by rectangle method.
Problem: We have 30 per cent and 50 per cent material. In what ratio shall they be mixed to produce 37 per cent material.



Desired ration is 13 parts of the 30 per cent and 7 parts of the 50 per cent. This will give us 20 parts of 37 per cent.

MAKING UP CHEMICAL SOLUTIONS

Percent Solution Table

%	Lb./Gal.	Oz./Gal.
1	0.084	1.3 oz.
2	0.170	2.7 oz.
3	0.258	4.1 oz.
4	0.348	5.6 oz.
5	0.440	7.0 oz.
6	0.533	8.5 oz.
7	0.629	10.1 oz.
8	0.726	11.6 oz.
9	0.825	13.2 oz.
10	0.929	14.9 oz.

Handy Conversions

Cu. ft. x 7.5	= Gallons
Gal. x 8.34	= Lbs. of Water
Gal. x 3785	= ML
Gal./Hour x 63	= ML/Minute
Grains/Gal. x 0.143	= Lbs./1000 Gal.
Grains/Gal. x 17.1	= PPM
Grams x 15.43	= Grains
MGD x 694	= GPM
1%	= 10,000 PPM
Ounces x 28.35	= Grams
Ounces (Fluid) x 29.57	= ML
Pound x 454	= Grams
Pounds x 16	= Ounces
PPM x 8.34	= Lbs./Mil. Gal.
PPM/120	= Lbs./1000 Gal.
Quarts x 946	= ML

PERIODIC TABLE OF THE ELEMENTS

1a	2a	3b	4b	5b	6b	7b	8	1b	2b	3a	4a	5a	6a	7a	0	Orbit
1 +1 −1 H 1.008 1															2 0 He 4.00260 2	K
3 +1 Li 6.94 2 1	4 +2 Be 9.01218 2 2									5 +3 B 10.81 2 3	6 +2 +4 −4 C 12.011 2 4	7 +1 +2 +3 +4 +5 −1 N 14.0067 −2 −3 2 5	8 −2 O 15.9994 2 6	9 −1 F 18.9984 2 7	10 0 Ne 20.179 2 8	K L
11 +1 Na 22.9898 2 8 1	12 +2 Mg 24.305 2 8 2									13 +3 Al 26.9815 2 8 3	14 +2 +4 −4 Si 28.086 2 8 4	15 +3 +5 −3 P 30.9738 2 8 5	16 +4 +6 −2 S 32.06 2 8 6	17 +1 +5 +7 −1 Cl 35.453 2 8 7	18 0 Ar 39.948 2 8 8	K L M
19 +1 K 39.102 8 8 1	20 +2 Ca 40.08 8 8 2	21 +3 Sc 44.9559 8 9 2	22 +2 +3 +4 Ti 47.90 8 10 2	23 +2 +3 +4 +5 V 50.941 8 11 2	24 +2 +3 +6 Cr 51.996 8 13 1	25 +2 +3 +4 +7 Mn 54.9380 8 13 2	26 +2 +3 Fe 55.847 8 14 2	27 +2 +3 Co 58.9332 8 15 2	28 +2 +3 Ni 58.71 8 16 2	29 +1 +2 Cu 63.546 8 18 1	30 +2 Zn 65.37 8 18 2	31 +3 Ga 69.72 8 18 3	32 +2 +4 Ge 72.59 8 18 4	33 +3 +5 −3 As 74.9216 8 18 5	34 +4 +6 −2 Se 78.96 8 18 6	35 +1 +5 −1 Br 79.904 8 18 7	36 0 Kr 83.80 8 18 8	K L M N
37 +1 Rb 85.47 8 18 1	38 +2 Sr 87.62 18 8 2	39 +3 Y 88.9059 18 9 2	40 +4 Zr 91.22 18 10 2	41 +3 +5 Nb 92.9064 18 12 1	42 +6 Mo 95.94 18 13 1	43 +4 +6 +7 Tc 98.9062 18 13 2	44 +3 Ru 101.07 18 15 1	45 +3 Rh 102.9055 18 16 1	46 +2 +4 Pd 106.4 18 18 0	47 +1 Ag 107.868 18 18 1	48 +2 Cd 112.40 18 18 2	49 +3 In 114.82 18 18 3	50 +2 +4 Sn 118.69 18 18 4	51 +3 +5 −3 Sb 121.75 18 18 5	52 +4 +6 −2 Te 127.60 18 18 6	53 +1 +5 +7 −1 I 126.9045 18 18 7	54 0 Xe 131.30 18 18 8	K L M N O
55 +1 Cs 132.9055 18 1 1	56 +2 Ba 137.34 18 8 2	57* +3 La 138.9055 18 9 2	72 +4 Hf 178.49 32 10 2	73 +5 Ta 180.947 32 11 2	74 +6 W 183.85 32 12 2	75 +4 +6 +7 Re 186.2 32 13 2	76 +3 +4 Os 190.2 32 14 2	77 +3 +4 Ir 192.22 32 15 2	78 +2 +4 Pt 195.09 32 16 2	79 +1 +3 Au 196.9665 32 18 1	80 +1 +2 Hg 200.59 32 18 2	81 +1 +3 Tl 204.37 32 18 3	82 +2 +4 Pb 207.2 32 18 4	83 +3 +5 Bi 208.9806 32 18 5	84 +2 +4 Po (209) 32 18 6	85 At (210) 32 18 7	86 0 Rn (222) 32 18 8	K L M N O
87 +1 Fr (223) 18 8 1	88 +2 Ra (226) 18 8 2	89** +3 Ac (227) 18 9 2	104 — 32 10 2	105														N O P
																		O P Q

Atomic Number — 50 +2 — Oxidation States
Symbol — Sn +4 — KEY TO CHART
Atomic Weight — 118.69
18 18 4 — Electron Configuration

Transition Elements

Transition Elements

Group 8

*Lanthanides	58 +3 +4 Ce 140.12 20 8 2	59 +3 Pr 140.9077 21 8 2	60 +3 Nd 144.24 22 8 2	61 +3 Pm (145) 23 8 2	62 +2 +3 Sm 150.4 24 8 2	63 +2 +3 Eu 151.96 25 8 2	64 +3 Gd 157.25 25 9 2	65 +3 Tb 158.9254 27 8 2	66 +3 Dy 162.50 28 8 2	67 +3 Ho 164.9303 29 8 2	68 +3 Er 167.26 30 8 2	69 +3 Tm 168.9342 31 8 2	70 +2 +3 Yb 173.04 32 8 2	71 +3 Lu 174.97 32 9 2	N O P
**Actinides	90 +4 Th 232.0381 18 10 2	91 +5 +4 Pa 231.0359 20 9 2	92 +3 +4 +5 +6 U 238.029 21 9 2	93 +3 +4 +5 +6 Np 237.0482 22 9 2	94 +3 +4 +5 +6 Pu (244) 24 8 2	95 +3 +4 +5 +6 Am (243) 25 8 2	96 +3 Cm (247) 25 9 2	97 +3 +4 Bk (247) 27 8 2	98 +3 Cf (251) 28 8 2	99 Es (254) 29 8 2	100 Fm (257) 30 8 2	101 Md (256) 31 8 2	102 No (254) 32 8 2	103 Lr 32 9 2	O P Q

Numbers in parentheses are mass numbers of most stable isotope of that element

MELTING AND BOILING POINTS, AND ATOMIC WEIGHTS OF THE ELEMENTS

Based on the assigned relative atomic mass of $^{12}C = 12$

The following values apply to elements as they exist in materials of terrestrial origin and to certain artificial elements. When used with the footnotes, they are reliable to ±1 in the last digit, or ±3 if that digit is in small type.

Name	Symbol	At. No.	At. wt.	M.P. °C	B.P. °C
Actinium	Ac	89	(227)	1050	3200 ± 300
Aluminum	Al	13	26.9815[5]	660.37	2467
Americium	Am	95	(243)	994 ± 4	2607
Antimony	Sb	51	121.75	630.74	1750
Argon	Ar	18	39.946[3,4,6]	−189.2	−185.7
Arsenic (grey)	As	33	74.9216[5]	817 (28 atm)	613 (sub.)
Astatine	At	85	~210	302	337
Barium	Ba	56	137.34	725	1640
Berkelium	Bk	97	(247)	—	—
Beryllium	Be	4	9.01218[5]	1278 ± 5	2970 (5 mm)
Bismuth	Bi	83	208.9806[5]	271.3	1560 ± 5
Boron	B	5	10.81[3,4,6]	2300	2550 (sub.)
Bromine	Br	35	79.904[3]	−7.2	58.78
Cadmium	Cd	48	112.40	320.9	765
Calcium	Ca	20	40.08	839 ± 2	1484
Californium	Cf	98	(251)	—	—
Carbon	C	6	12.011[3,4,6]	~3550	4827
Cerium	Ce	58	140.12	799 ± 3	3426
Cesium	Cs	55	132.9055[5]	28.40 ± 0.01	678.4
Chlorine	Cl	17	35.453[3]	−100.98	−34.6
Chromium	Cr	24	51.996[3]	1857 ± 20	2672
Cobalt	Co	27	58.9332[5]	1495	2870
Copper	Cu	29	63.546[3,4]	1083.4 ± 0.2	2567
Curium	Cm	96	(247)	1340 ± 40	—
Dysprosium	Dy	66	162.50	1412	2562
Einsteinium	Es	99	(254)	—	—
Erbium	Er	68	167.26	1529	2863
Europium	Eu	63	151.96	822	1597
Fermium	Fm	100	(257)	—	—
Fluorine	F	9	18.9984[5]	−219.62	−188.14
Francium	Fr	87	(223)	(27)	(677)
Gadolinium	Gd	64	157.25	1313 ± 1	3266
Gallium	Ga	31	69.72	29.78	2403
Germanium	Ge	32	72.59	937.4	2830
Gold	Au	79	196.9665[5]	1064.43	2807
Hafnium	Hf	72	178.49	2227 ± 20	4602
Helium	He	2	4.00260[3,4]	−272.2[2.5e+2]	−268.934
Holmium	Ho	67	164.9303[5]	1474	2695
Hydrogen	H	1	1.0080[3,4]	−259.14	−252.87
Indium	In	49	114.82	156.61	2080
Iodine	I	53	126.9045[5]	113.5	184.35
Iridium	Ir	77	192.22	2410	4130
Iron	Fe	26	55.84[3]	1535	2750
Krypton	Kr	36	83.80	−156.6	−152.30 ± 0.10
Lanthanum	La	57	138.9055[5]	921 ± 5	3457
Lawrencium	Lr	103	(257)	—	—
Lead	Pb	82	207.2[3,4]	327.502	1740
Lithium	Li	3	6.941[3,4,6]	180.54	1347
Lutetium	Lu	71	174.97	1663 ± 5	3395
Magnesium	Mg	12	24.305[5]	648.8 ± 0.5	1090
Manganese	Mn	25	54.9380[5]	1244 ± 3	1962
Mendelevium	Md	101	(256)	—	—
Mercury	Hg	80	200.59[3]	−38.87	356.58

Name	Symbol	At. No.	At. wt.	M.P. °C	B.P. °C
Molybdenum	Mo	42	95.94[3]	2617	4612
Neodymium	Nd	60	144.24[3]	1021	3068
Neon	Ne	10	20.179[3,4]	−248.67	−246.048
Neptunium	Np	93	237.0482[5]	640 ± 1	3902
Nickel	Ni	28	58.71	1453	2732
Niobium (Columbium)	Nb	41	92.9064[5]	2468 ± 10	4742
Nitrogen	N	7	14.0067[3,4,6]	−209.86	−195.8
Nobelium	No	102	(254)		
Osmium	Os	76	190.2	3045 ± 30	5027 ± 100
Oxygen	O	8	15.9994[3,4,6]	−218.4	−182.962
Palladium	Pd	46	106.4	1552	3140
Phosphorus	P	15	30.9738	44.1 (white)	280 (white)
Platinum	Pt	78	195.09	1772	3827 ± 100
Plutonium	Pu	94	(244)	641	3232
Polonium	Po	84	(~210)	254	962
Potassium	K	19	39.10[3]	63.65	774
Praseodymium	Pr	59	140.907[5,6]	931	3512
Promethium	Pm	61	(145)	~1080	2460(?)
Protoactinium	Pa	91	231.0359[5]	<1400	—
Radium	Ra	88	226.0254[3,4,6]	700	1140
Radon	Rn	86	(~222)	−71	−61.8
Rhenium	Re	75	186.2	3180	5627 (est.)
Rhodium	Rh	45	102.9055[5]	1966 ± 3	3727 ± 100
Rubidium	Rb	37	85.4678[3]	38.89	688
Ruthenium	Ru	44	101.07	2310	3900
Samarium	Sm	62	150.4	1077	1791
Scandium	Sc	21	44.9559[5]	1541	2831
Selenium	Se	34	78.96	217	684.9 ± 1.0
Silicon	Si	14	28.086[3]	1410	2355
Silver	Ag	47	107.868[3]	961.93	2212
Sodium	Na	11	22.9898[5]	97.81 ± 0.03	882.9
Strontium	Sr	38	87.62[3]	769[7]	1384
Sulfur	S	16	32.06[3]	112.8	444.674
Tantalum	Ta	73	180.9479[3]	2996	5425 ± 100
Technetium	Tc	43	98.9062[7]	2172	4877
Tellurium	Te	52	127.60	449.5 ± 0.3	989.8 ± 3.8
Terbium	Tb	65	158.9254[5]	1356	3123
Thallium	Tl	81	204.37[3]	303.5	1457 ± 10
Thorium	Th	90	232.0381[3]	1750	~4790
Thulium	Tm	69	168.9342[5]	1545 ± 15	1947
Tin	Sn	50	118.69[3]	231.9681	2270
Titanium	Ti	22	47.90[3]	1660 ± 10	3287
Tungsten	W	74	183.85[3]	3410 ± 20	5660
Uranium	U	92	238.029[3,4,6]	1132.3 ± 0.8	3818
Vanadium	V	23	50.9414[3,5]	1890 ± 10	3380
Wolfram (see Tungsten)					
Xenon	Xe	54	131.30	−111.9	−107.1 ± 3
Ytterbium	Yb	70	173.04	819	1194
Yttrium	Y	39	88.9059[5]	1522	3338
Zinc	Zn	30	65.38	419.58	907
Zirconium	Zr	40	91.22	1852 ± 2	4377

[1] Monoisotopic element.

[2] Element with one predominant isotope (about 99 to 100 %, abundance).

[3] Element for which the atomic weight is based on calibrated measurements.

[4] Element for which variation in isotopic abundance in terrestrial samples limits the precision of the atomic weight given.

[5] Element for which users are cautioned against the possibility of large variations in atomic weight due to inadvertent or undisclosed artificial isotopic separation in commercially available materials.

[6] Most commonly available long-lived isotope.

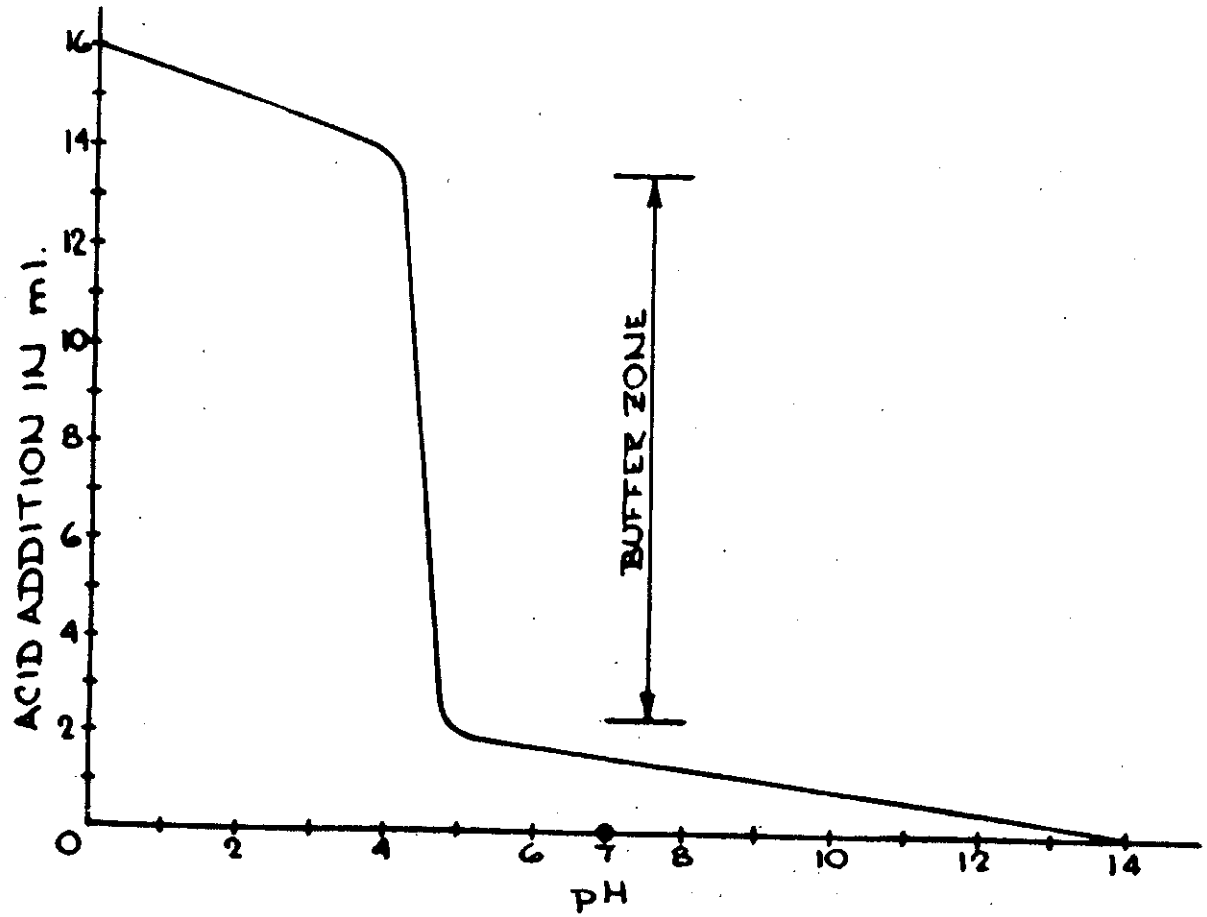
[7] In some geological specimens this element has a highly anomalous isotopic composition, corresponding to an atomic weight significantly different from that given.

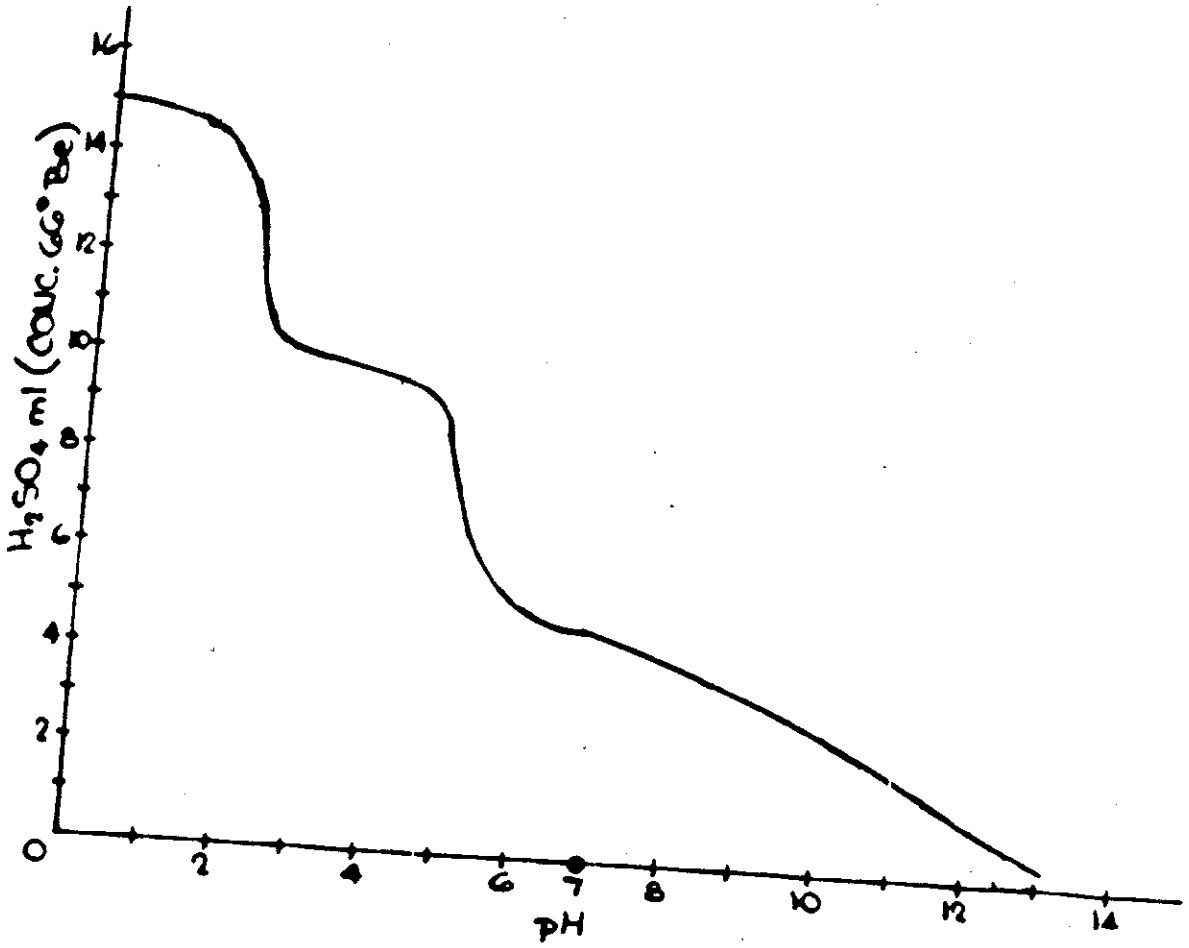
$$\text{Acid} + \text{Alkali} \longrightarrow \text{Salt} + \text{Water} \quad (1)$$

$$H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O \quad (2)$$

$$H_2SO_4 + Ca(OH)_2 \longrightarrow CaSO_4 + 2H_2O \quad (3)$$

$$2H_2SO_4 + Ca(OH)_2 + MgO \longrightarrow CaSO_4 + MgSO_4 + 3H_2O \quad (4)$$


ACID ADDITION IN ml.
16
14
12
10
8
6
4
2
0
BUFFER ZONE
2
4
6
7
8
10
12
14
pH



Sulfuric acid breaks down into different ion steps as the pH changes, $H^{++}SO_4^{=}$ and H^{+} HSO_4^{-}. As the change in ionization takes place, the rate of pH change with acid addition will change. With some acids, the rate of change with further acid addition can be very small even for a large addition of acid.
For example

Table

Compounds or Ions in Untreated Cyanide Waste Having A Definite Demand for Chlorine
(Showing Ionization)

1.	Free Sodium and Potassium Cyanide	: Na^+CN^- or K^+CN^-
2.	Hydrogen Cyanide	: HCN
3.	Na or K Cadmium Cyanide Complex Ion	: $-Cd(CN)_4^{-2}$, and/or $Cd(CN)_2$
4.	Na or K Copper Cyanide Complex Ion	: $-Cu(CN)_3^{-2}$, and/or CuCN
5.	Na or K Nickel Cyanide Complex Ion	: $-Ni(CN)_4^{-2}$, and/or $Ni(CN)_2$
6.	Na or K Silver Cyanide Complex Ion	: $-Ag(CN)_2^{-1}$, and/or AgCN
7.	Na or K Zinc Cyanide Complex Ion	: $-Zn(CN)_4^{-2}$, and/or $Zn(CN)_2$
8.	Na or K Ferrocyanide Complex Ion	: $-Fe(CN)_6^{-4}$
9.	Metallic Ferrocyanides.	
10.	Ammonia	: NH_3 or NH_4^{+1}

11. Sulphides ($-S^{-2}$), Sulfites ($-SO_3^{-2}$), Thiosulfates ($-S_2O_3^{-2}$), Cyanates ($-CNO^{-1}$) and Thiocyanates ($-CNS^{-1}$).

OXIDATION OF CYANIDES BY USE OF CHLORINE COMPOUNDS

COMMON FORMS OF CHLORINE AVAILABLE

CHLORINE GAS-	Cl_2	Mol. Wt. 71	100% CHLORINE
HYPOCHLOROUS ACID-	HOCl	Mol. Wt. 52.5	67% CHLORINE
SODIUM HYPOCHLORIDE-	NaOCl	Mol. Wt. 74.5	47% CHLORINE

FIRST STAGE CYANIDE OXIDATION (pH above 8.5)

$$2Cl_2 + 4NaOH + 2NaCN \rightarrow 2NaCNO + 4NaCl + 2H_2O$$

ByWt. 2.73 3.07 1

SECOND STAGE CYANIDE OXIDATION (pH above 7.5)

$$3Cl_2 + 6NaOH + 2NaCNO \rightarrow 2NaHCO_3 + N_2 + 6NaCl + 2H_2O$$

SODIUM HYDROXIE — SODIUM CYANATE — SODIUM BICARBONATE — NITROGEN — SODIUM CHLORIDE — WATER

ByWt. 4,09 4.62 1

TOTAL Cl/Cn 6,82
(theoretical)

TOTAI CAUSTIC/Cn 7.69

USING SODIUM HYPOCHLORITE

$$HOCl + HCl + 2NaOH + NaCN \rightarrow NaCNO + 2NaCl + 2H_2O$$

$$5NaOCl + 5NaCl + H_2O + 2NaCN \rightarrow 2NaHCO_3 + N_2 + 10NaCl$$

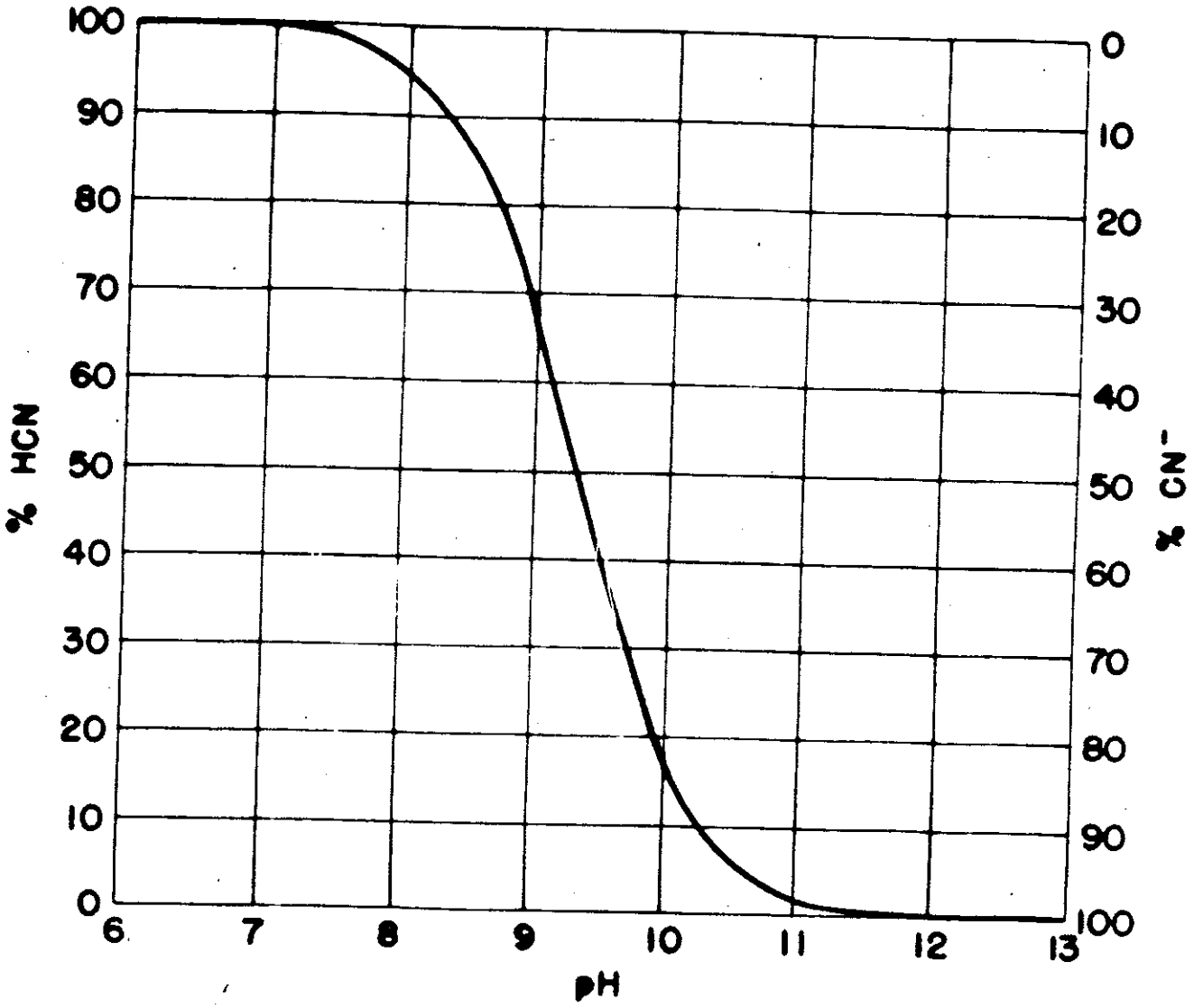


Fig. 1 - RELATIONSHIP BETWEEN HCN AND CN^- AT VARIOUS pH VALUES

Reduction in Acid Solution

Sulfur Dioxide Compunds		Hexavalent Chromic Acid		Trivalent Chromic Sulfate		Water
$3SO_2$	+	$2H_2CrO_4$	→	$Cr_2(SO_4)_3$	+	H_2O
1.9		1 (AsCr)				

Reduction with Sodium Bisulfite- $NaHSO_3$

$$3NaHSO_3 + 1.5H_2SO_4 + 2H_2CrO_4 \rightarrow Cr_2(SO_4)_3 + 1.5Na_2SO_4 + H_2O$$

3.0 1.4 1 (AsCr)

Reduction with Sodium Meta Bisulfite

$$1.5Na_2S_2O_5 + 1.5H_2SO_4 + 2H_2CrO_4 \rightarrow Cr_2(SO_4)_3 + 1.5Na_2SO_4 + 3.5H_2O$$

2.4 1.4 1 (AsCr)

Removal in Slightly Alkaline Solution

Hyd. Lime		Chromic Sulfate		Chromic Hydroxide		Calcium Sulfate
$3Ca(OH)_2$	+	$Cr_2(SO_4)_3$	→	$2Cr(OH)_3$	+	$3CaSO_4$
2.5		1 (AsCr)		2.0		3.9

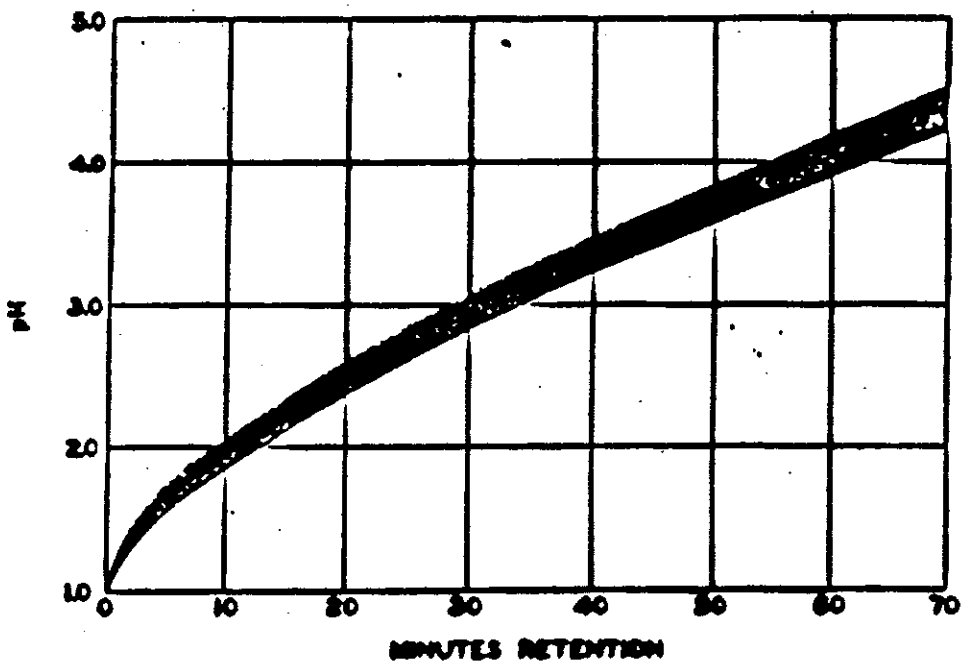


Fig. 1 —Effect of pH level on time required to completely reduce hexavalent chromium to trivalent chromium in presence of slight excess of sulfur dioxide.

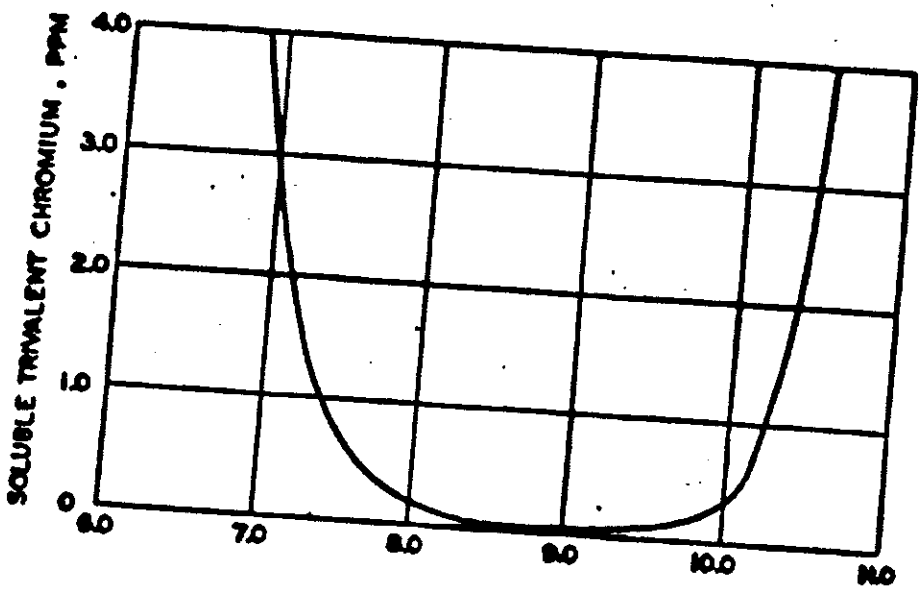


Fig. 2 —Effect of pH on solubility of trivalent chromium. After Chamberlain and Day

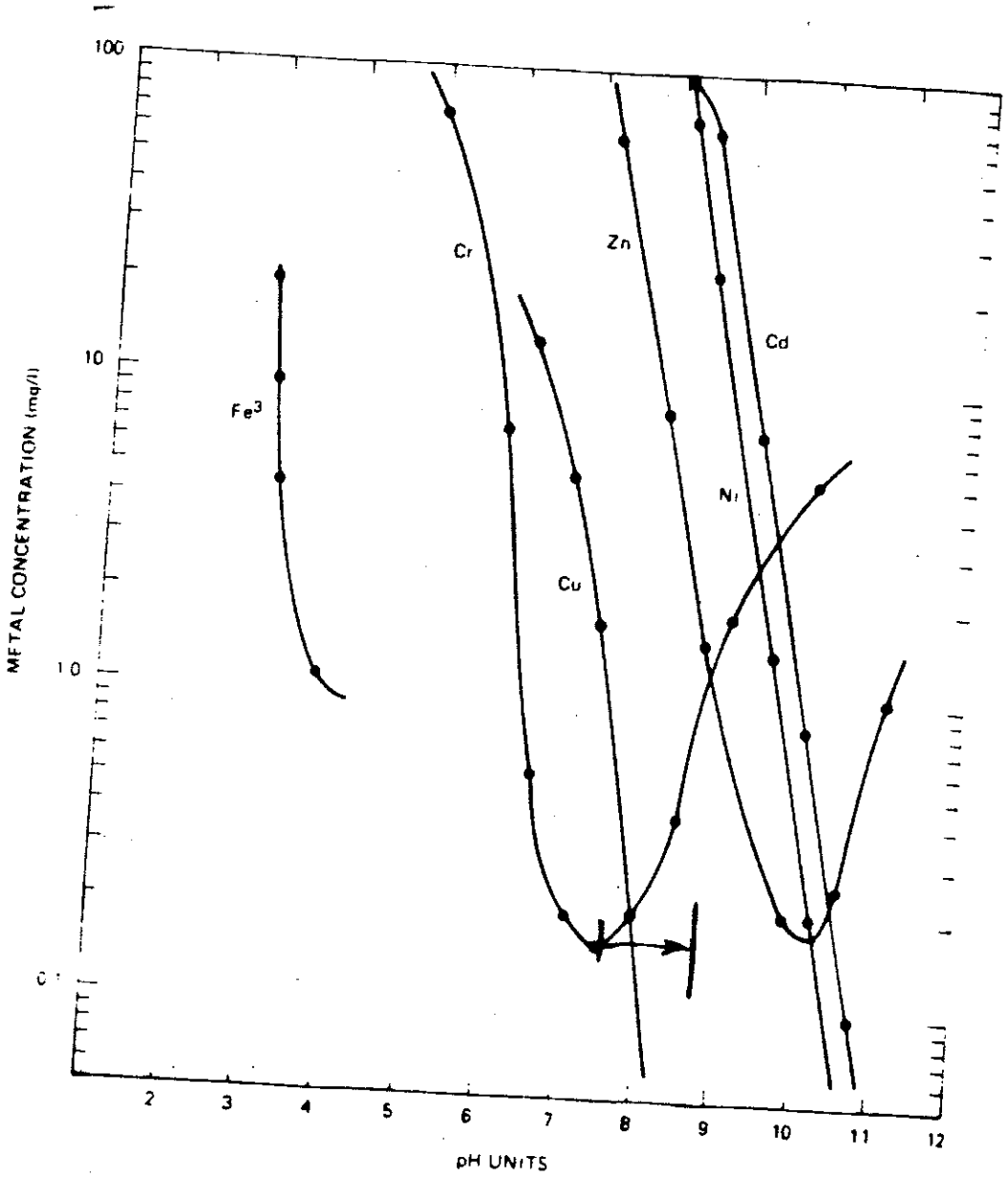


Figure IV-1. Precipitation of metal salts versus pH. See R. Weiner.[28]

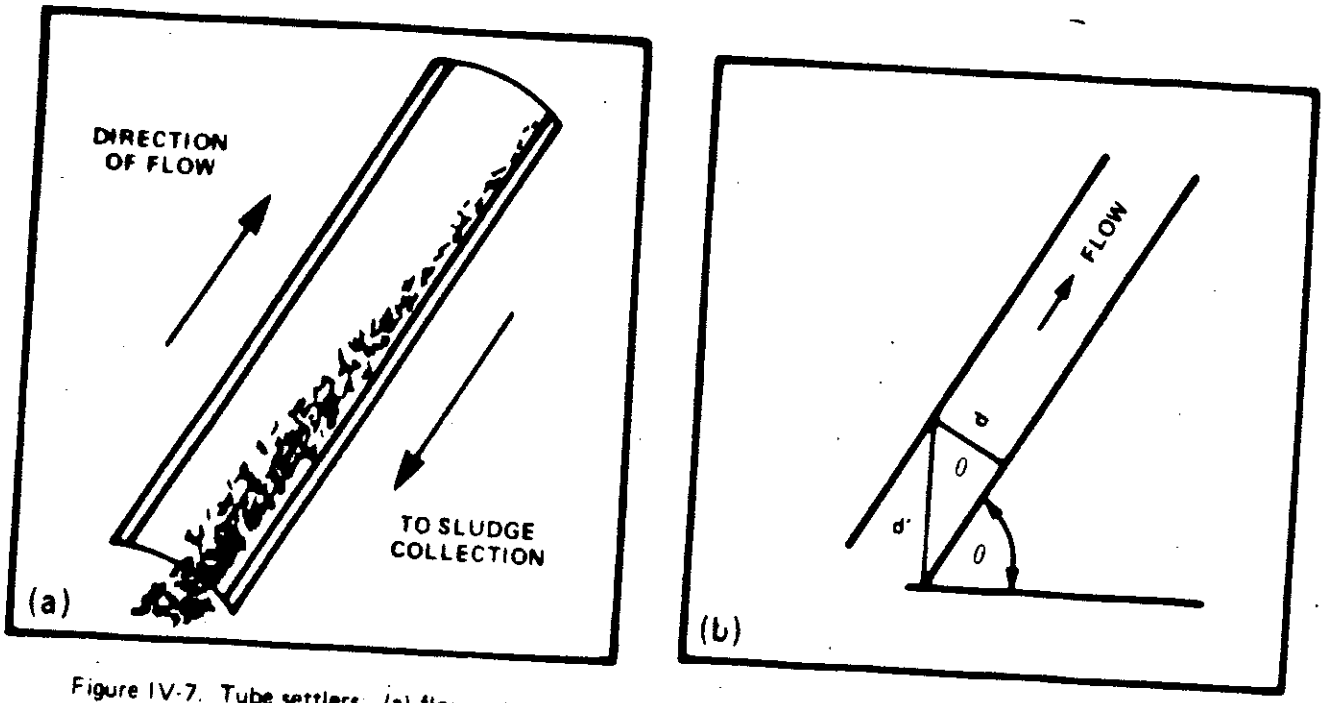


Figure IV-7. Tube settlers: (a) flow pattern, (b) inclined tube. (Courtesy of Neptune MicroFloc, Inc.)

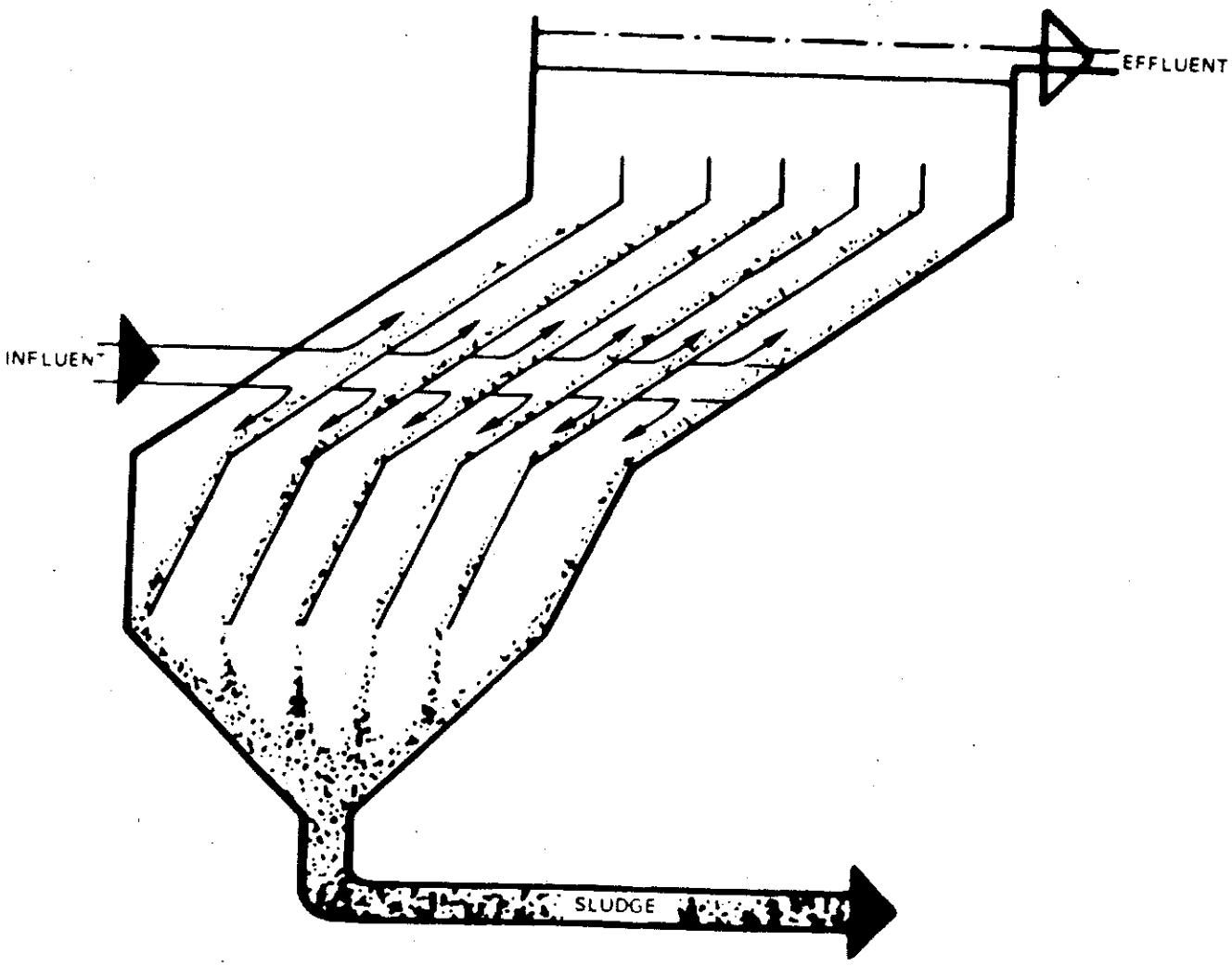


Figure IV-12. Lamella thickener. (Courtesy of Parkson Corp.)

Coagulation Tests (Jar Tests)

Equipment:
Stirring device - to operate at rate of 10-15 r.p.m.
Glass jars - for use with stirring device
Filter funnels
Filter paper
Chemicals used in coagulation-coagulant, coagulant aid and any other used in plant practice. Use solutions containing 1000 ppm of the chemical.
Equipment for the determination of, suspended solids, pH.

Procedure
Known volumes of raw water in laboratory jars are treated with varying quantities of the chemicals used in plant practice. These are stirred, the floc formation observed, and the results of the treatment after certain periods of coagulation noted. It is desirable to simulate in the laboratory tests the conditions of mixing and sedimentation time, etc. that actually exist in the plant. A simple stirring device to provide slow mixing for 10-15 minute periods will aid coagulation and will give more accurate and reliable results for the tests.

1. Measure known volume of raw water, usually 500 ml., into each of 6 jars or beakers and place jars in stirring device.
2. Starting with first jar at left add gradually increasing doses of chemicals used for coagulation. Select series of doses so that the first jar will represent under-treatment and the last jar will represent over-treatment.
3. Start stirring device and stir portions of water at rate of 10-15 r.p.m. of stirrer blades.
4. Stir for 15 minutes.
5. Observe floc formation during stirring period. Record those test portions showing good or excellent floc formation.
6. Allow floc to settle, usually 15 to 60 minutes.
7. Withdraw portions of clear settled water for each test portion.
8. Determine turbidity, pH, and total of each portion in step 7.

JAR TEST DATA SHEET

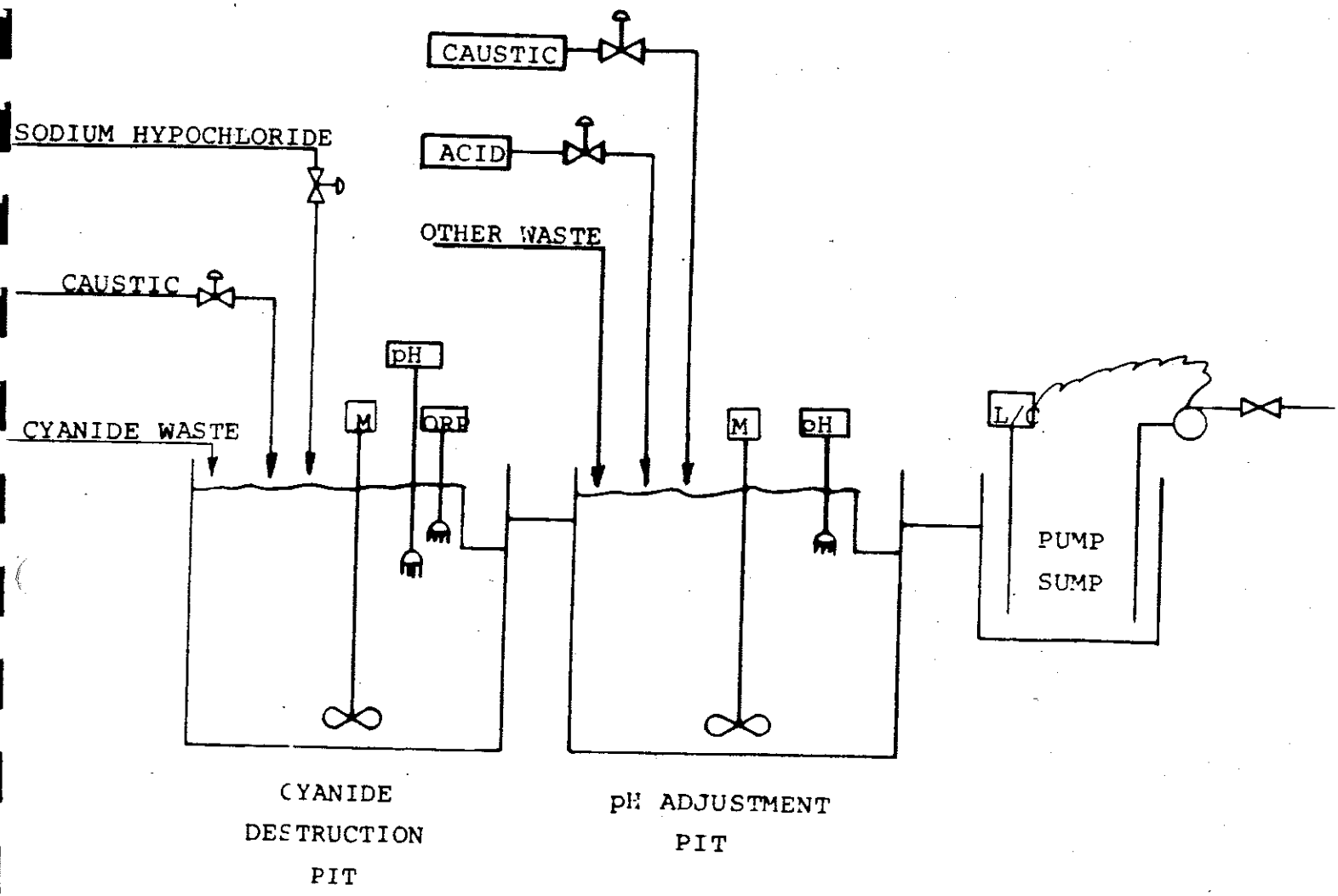
Type of Waste _____

Operator _____ Date _____

SAMPLE NO.	TYPE COAGULANT	DOSAGE mg/1	VOLUME IN JAR LITER	TIME OF START OF TEST.	TIME AT HIGH RATE		TIME AT LOW RATE		OBSERVATIONS							
									TIME- 5 min.		10. min.		15 min.		30 min.	
					rpm	min	rpm	min	Size Floc	Settling	Size Floc	Settling	Size Floc	Settling	Size Floc	Set-tlin

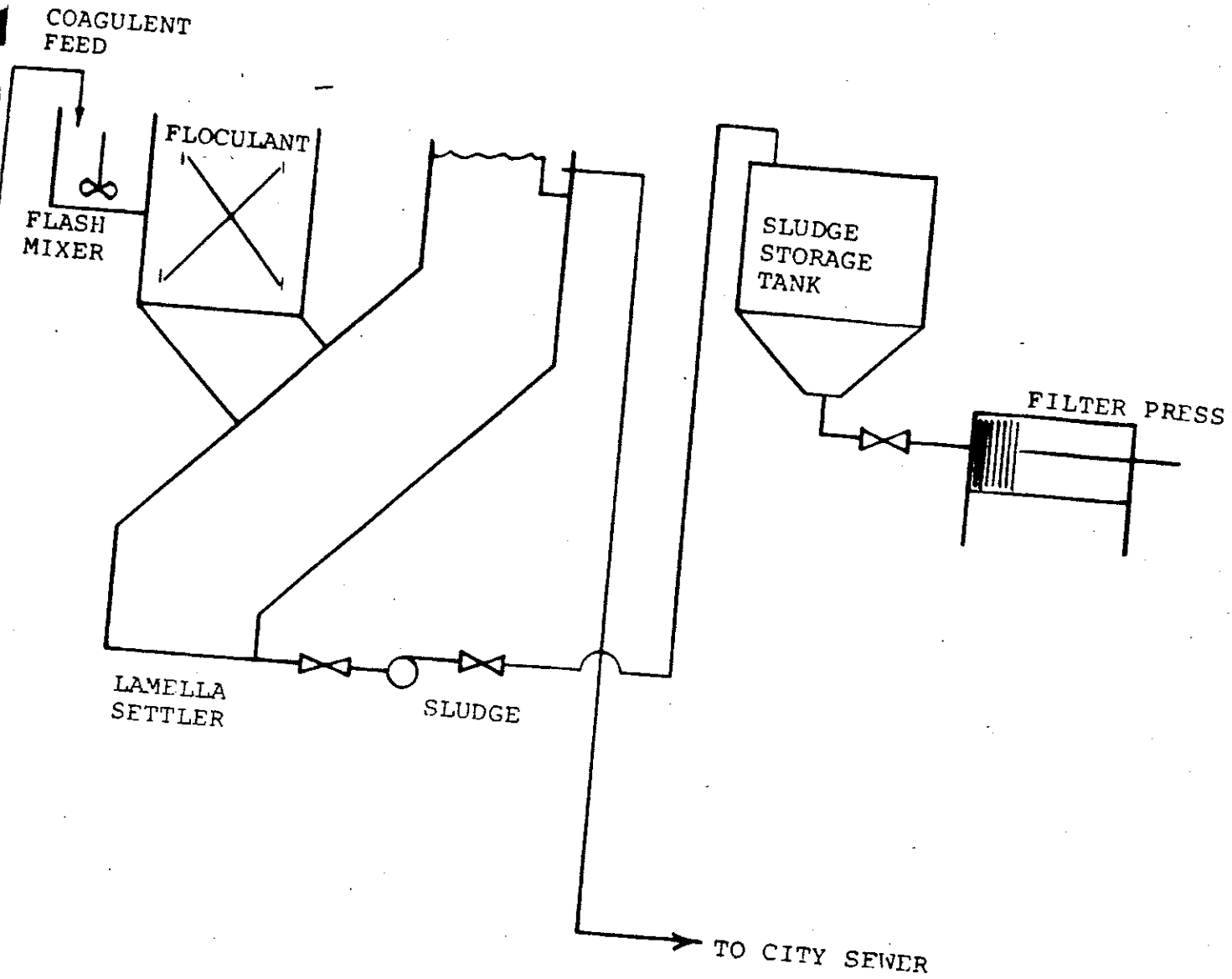
Optimum pH _____

Optimum dosage rate _____ mg/1



SIMPLIFIED FLOW SHEET

RINSE WATER WASTE TREATMENT FACILITY
UNION SWITCH AND SIGNAL CO.



SIMPLIFIED FLOW SHEET

RINSE WATER WASTE TREATMENT FACILITY
UNION SWITCH AND SIGNAL CO.

SECTION - SAFETY

Employee hazards in industrial waste treatment plants include exposure to:

1. Physical injuries.
2. Body damage from handling plant chemicals.
3. Noxious gases or vapors.

These occupational hazards are largely avoided by the execution of safe practices and the use of safety equipment. The dangers are many; this is supported by the man-hour accident records of insurance companies.

It is the responsibility of waste treatment plant supervisors to acquaint themselves with the hazards associated with plant maintenance and operation, and to take steps to eliminate them. Accidents do not happen--they are caused! By thinking "safety", it soon becomes a state of mind.

A. Prevention of Physical Injuries

1. Lift objects safely. Teach employees to lift objects with the aid of the leg muscles instead of the back. This will reduce ruptures and back injuries. Use hoists or power trucks to lift heavy objects and avoid hurrying. See that adequate help under proper supervision is available. The handling of objects constitutes the major source of compensation injuries.

2. Prevent falls. Be cautious when using vertical ladders or steep, narrow stairs. Install a hoop cage around vertical ladders more than 10 ft. high. Employ good housekeeping. Keep tools and portable equipment in designated places. Maintain walks, stair treads, and ladder rungs free of grease, oil, or ice. Remove debris from working areas. Keep manhole covers in place or provide guards. Erect judiciously placed warning signs at danger spots. Install fencing or guard rails around settling tanks or at other locations where operators might fall. Falls are the second largest source of compensation injuries.

3. Avoid body injuries. Remove manhole covers preferably with a hook lifter rather than a pick. Unless the cover is very heavy, it is safer to have one man pull the cover free of the manhole. Never leave a cover partially over a manhole shaft. Instruct employees to wear work gloves when handling large objects.

Provide metal guards for all moving parts of machinery. Use ample natural or artificial lighting in work areas. The employment of light-colored paints for interior rooms is suggested.

4. Avoid electrical shocks or injuries. Place rubber mats in front of switchboards. Open the main control switch and tag it when working on a motor or other electrical equipment. See that all electrical equipment is well grounded and all exposed wire taped.

5. Protect plant against fire. Equip the plant with an adequate number of fire extinguishers. In addition to carbon dioxide extinguishers for electrical fires, probide one or more of the soda ash and acid type. Stage fire and emergency first-aid drills at large plants.

6. General Preventive Measures: Instruct all operators to use a safety belt in manholes, tanks, or other structures deeper than 8 to 10 ft. Two men should stand by to remove the operator, if necessary. See that all operators have first-aid training. Post prominently the phone numbers of several physicians, the nearest hospital, the nearest fire station and one or more ambulance services.

B. Safety in Handling Sulfuric Acid

Sulfuric acid in any form should command the respect of everyone who handles and uses it. This doesn't mean that anyone should develop a fear complex toward sulfuric acid, but it does mean that before starting to work with it, an individual should be aware of its properties and know what precautions to take to handle it with safety and how to act in case of accidental contact of person, clothing or equipment. Suggestions for accomplishing these objectives are given in the following paragraphs.

1. First Aid Measures

a. If for any reason sulfuric acid should come into contact with the eyes or skin, the affected part should be flooded immediately with a copious flow of clean water. This washing should be continued for at least 15 minutes.

b. Following thorough washing, the burn should be neutralized according to the recommendations of your company physician, pending his arrival. Neutralization with an alkaline solution should be postponed until washing is completed, as the heat of reaction between a base and sulfuric acid may cause additional irritation. A medical neutralizer is available in a stand in the operator building.

c. Expert medical attention must be provided promptly. Any acid burn may be serious.

d. Garments wetted with acid should be removed at once.

2. Protective Practices

a. Keep equipment clean, washing off all accumulations of solidified acid caused by small leaks.

b. When disconnecting equipment for repairs, make certain that there is no internal pressure on the equipment and that the equipment has been drained and washed.

c. Shield the packing glands of pumps in order to prevent spraying of acid in case the packing glands should leak.

d. When spillage has occurred, whether solid, flake, or liquid acid, the platform should be washed with a hose stream rather than swept.

C. Safety in Handling Caustic Soda

Caustic Soda in any form should command the respect of everyone who handles and uses it. This doesn't mean that anyone should develop a fear complex toward caustic soda, but it does mean that before starting to work with it, an individual should be aware of its properties and know what precautions to take to handle it with safety and how to act in case of accidental contact of person, clothing, or equipment. Suggestions for accomplishing these objectives are given in the

following paragraphs.

1. First Aid Measures

   a. If for any reason caustic soda liquid should come into contact with the eyes or skin, the affected part should be flooded immediately with a copious flow of clean water. This washing should be continued for at least 15 minutes. An eye fountain is available and will provide an adequate method for flushing the eyes.

   b. A safety shower has been provided as suitable means for flushing the skin.

   c. Following thorough washing, the burn should be neutralized according to the recommendations of your company physician, pending his arrival. Neutralization with acidic solutions should be postponed until washing is complete, as the heat of reaction between an acid and caustic soda may cause additional irritation. A 1% solution of ammonium chloride or a 4% solution of boric acid is commonly recommended for neutralizing caustic burns of the eyes. A 10% solution of ammonium chloride is suitable for application to the skin.

   d. Expert medical attention must be provided promptly. Any caustic burn may be serious.

   e. Garments wetted with caustic solution should be removed at once.

2. Protective Practices

   a. Keep equipment clean, washing off all accumulations of solidified caustic caused by small leaks.

   b. When disconnecting equipment for repairs, make certain that there is no internal pressure on the equipment and that the equipment has been drained and washed.

c. Shield the packing glands of pumps in order to prevent spraying of caustic solution in case the packing glands should leak.

d. When spillage has occurred, whether solid, flake or liquid caustic, the floor should be washed with a hose stream rather than swept.

D. Safety in Handling Sodium Metabisulfite

Sodium Metabisulfite is a fairly strong reducing agent and breathing of the dust may cause irritation. Keep away from heat. Highly toxic sulfur dioxide fumes are released upon heating. Water solutions of sodium metabisulfite are corrosive and should be handled with care. Spills of solid or liquid solutions of sodium metabisulfite should be flushed with large amounts of water.

1. Protective Equipment

Normal dust precautions should be followed and pretective clothing including face masks are recommended when handling solid sodium metabisulfite.

2. First Air

Any contact with the eyes should be flushed and ccpious amounts of clean water and a physician notified immediately. Contact with skin and clothing should be followed by flushing with water.

E. Safety in Handling Lime

Lime has a caustic reaction and therefore is irritating to the skin and respiratory system. In the form of dust, it is considered to be an industrial hazard. It can cause dermatitis, irritation of the eyes and muscous membranes.

(1) Protective equipment
Normal precautions should be employed to prevent spreading of the dust. Care should be taken when filling the hopper to prevent spilling the lime. Face masks and protective clothing may be used to protect eyes and skin.

(2) First Aid
Lime or calcium hydroxide should be immediately flushed from the eyes using copious amounts of warm water. Lime should be washed from the skin with water, as prolonged contact may be irritating.

(3) Safety Data Sheets
These are in the Appendix

F. Safety in Handling Polyelectrolyte.

The polyelectrolyte being used is generally acidic in nature and can cause an irritation of the skin. This is not true for all polyelectrolytes, therefore, the safety data sheets for the one selected should be consulted. Note, all polyelectrolytes when mixed with water are very viscious in the liquid form and when on the floor, they create a very slick surface. Therefore, if some of the polyelectrolyte is spilled in the dry form, it should be cleaned up still in the dry form if at all possible.

1. Protective Equipment
   Protective clothing including face masks and rubber aprons are recommended when handling polyelectrolytes.
2. First Aid Measures
   The polyelectrolyte should be immediately flushed from the eyes, using copious amounts of water. Polyelectrolytes should be washed from the skin with water as prolonged contact may be irritating.
3. Safety Data Sheets
   The S.D.S. for Dearborn 408 is available in the Appendix of the Engineering Report for Operations. Do not use any other polyelectrolyte until an S.D.S. on it has been received and has been determined safe for use and detailed safety procedures have been determined.

G. Safety in the Laboratory

1. General - A laboratory is a safe place to work as long as all detailed laboratory test procedures and equipment instructions are followed to the exact published recommendations. Only a well trained graduate chemist should try new unpublished chemical procedures. This is not the general training of the waste treatment facility operator or laboratory technician. Therefore, for safety purposes do not take any short cuts with any of the laboratory test procedures or change any of the chemicals in the published procedures.

   Follow the safety recommendations listed with each procedure used from the Hach Water Analysis Handbook for each test.

2. A copy of the general laboratory guide for operation of a water and waste water laboratory as published by the Georgia Environmental Protection Division has been placed in the laboratory for reference. The laboratory technician and/or operator should familiarize themselves with all safety precaution listed in this guide.

3. Safety showers with eye wash has been provided for emergency use in the laboratory. Do not be backward about using this equipment in the event a chemical is spilled.

H. Safety in Handling Process Chemicals

All of the process line treatment solutions are either strong acids or alkalies. Determine ahead of time what process bath chemical is to be treated and review the safety data sheet in the Engineering Report for Operations for that chemical prior to receiving it in the waste treatment facility. Know what is or is not in each batch tank before starting the transfer of any of the process chemicals. Do not add the strong process chemicals to each other. Follow the recommended treatment process step by step.

If a spill occurs, try to clean it up immediately. If some of the process chemicals are spilled on the operator, use the

MATERIAL SAFETY DATA SHEET

I PRODUCT IDENTIFICATION

NUFACTURER'S NAME	Cities Service Company	REGULAR TELEPHONE NO. 404-261-9100 EMERGENCY TELEPHONE NO. Chemtrec 800-424-93
SS	P. O. Box 50360 Atlanta, Georgia 30302	Street Address: 3445 Peachtree Road N. E. Atlanta, Georgia 30326
ADE NAME	Sulfuric Acid 66° Be (93.19%)	
NONYMS	Oil of Vitroil	
IPPING ME[1]	DOT: Sulfuric Acid IATA: -	

II HAZARDOUS INGREDIENTS[2]

MATERIAL OR COMPONENT	CAS NO.	% w/w	HAZARD DATA
Sulfuric acid (H_2SO_4)	7664939	93.0	Corrosive Materials (DOT) Aquatic hazardous substan
			LC_{50} = >10 to ≤100 mg/l 40 CFR 116 & 118 (EPA)
			Health hazards: Dehydrator. Causes third
			degree burns to skin. Corrosive, LC_{50} 8 hrs. =
			Mist inhalation 18 mg/m^3 for 1-2 month old g.p. and
			50 mg/m^3 for 18 month old g.p. TLV or TWA 8 hr.

III PHYSICAL DATA

exposure = 1 mg/m^3.

LING POINT, 760 MM HG	529° F.	MELTING POINT	- 26.0° F.
CIFIC GRAVITY (H_2O = 1)	1.8354 @ 60° F.	VAPOR PRESSURE	< 0.0038 mm Hq
OR DENSITY (AIR = 1)	3.38	SOLUBILITY IN H_2O % BY WT	Completely
OLATILES BY VOL.	-	EVAPORATION RATE (BUTYL ACETATE = 1)	N.A.
EARANCE AND ODOR	Clear colorless liquid. No odor.	Ph (AS IS) Ph (1% SOLN.)	strong acid

IV FIRE AND EXPLOSION DATA

SH POINT T METHOD)	None	AUTOIGNITION TEMPERATURE	None

MABLE LIMITS IN AIR, % BY VOL.	LOWER		UPPER	None

GUISHING A	Acid itself is not flammable but may cause ignition by contact with combustible liquids and solids. In fires where acid is present, use dry chemical, carbon dioxide or water fog.
AL FIRE TIN ED S	Do not allow water to enter storage containers as a violent reaction can occur. Also hydrogen gas can accumulate in containers and care must be taken not to ignite. Wear rubber suits, rubber gloves, rubber boots, goggles or face shield, and hard hat.
UAL FIRE EXPLOSION RD	The acid will not burn but can start fires with organic materials, nitrates, carbides, chlorates, and metallic powders. Hydrogen, a highly flammable and explosive gas is generated by acid action on most metals. Hydrogen gas can accumulate in containers and care must be taken not to ignite it.

HEALTH HAZARD DATA	HAZARD CLASSIFICATION	BASIS FOR CLASSIFICATION	SOURCE
ROUTES OF EXPOSURE INHALATION	Corrosive	LC_{50} 8 hrs. Sulfuric acid mist = 18 mg/m^3 for 1-2 mo. old guinea pigs or 50 mg/m^3 for 18 mo. old g.p. 5 mg/m^3 is distinctly objectionable level. TWA - 8 hrs. - 1 mg/m^3 set for exposure.	1, 2 16 CFR 1500. 3, 4 29 CFR 1910.10
SKIN CONTACT	Corrosive	-	1, 2, 3 16 CFR 1500.
SKIN ABSORPTION	Corrosive	-	1, 2, 3 16 CFR 1500.
EYE CONTACT	Corrosive	-	1, 2, 3 16 CFR 1500.
INGESTION	Corrosive	-	1, 2, 3 16 CFR 1500.

EFFECTS OF OVEREXPOSURE

ACUTE OVEREXPOSURE: Tissue destruction upon exposure and dehydration. May cause third degree burns.

CHRONIC OVEREXPOSURE: Inhalation of mist can cause bronchitis hyperemia, epithelial degenerat of the larynx, trachea, and bronchi with laryngeal or bronchial spasms.

EMERGENCY AND FIRST AID PROCEDURES

EYES: If even small amounts of sulfuric acid enter the eyes, immediat irrigate with large amounts of water for at least 15 minutes. Ho eyelids apart during irrigation. Send patient to a physician or eye specialist immedia ly. Continue washing eyes during transit if needed.

SKIN: Wash with large amounts of water and remove clothing and shoes under shower. Seek medical attention.

INHALATION: Remove worker from exposure and seek medical aid.

INGESTION: Drink large quantities of water immediately to reduce concentration. Seek medical aid immediately. Do not induce vomiting.

NOTES TO PHYSICIAN: Treat as highly corrosive material.

References: 1) The respiratory response of guinea pigs to sulfuric acid mists. Amdor, M. O. Archives of Industrial Health. 18: 407-14. 1958.
2) Dangerous Properties of Industrial Materials. N. Irving Sax. 4th Edition. Van Nostrand Reinhold Co., N. Y.
3) Properties and Essential Information for Safe Handling and Use of Sulfuric Acic Chemical Safety Data Sheet SD-20. Manufacturing Chemists Assn., Washington D. C.
4) Occupational Exposure to Sulfuric Acid. HEW Publication No. (NIOSH) 74-128.

CONDITIONS CONTRIBUTING TO INSTABILITY

Contact with metal powders may release hydrogen, a highly flammable gas. Contact with combustible materials may cause them to ignite.

INCOMPATIBILITY Do not pour water into acid. Do not store near nitrates, carbides, chlorates, cyanides, or other combustible organic substances. Do not mix with metal powders as hydrogen, a highly flammable and explosive gas, can be generated.

HAZARDOUS DECOMPOSITION PRODUCTS Hydrogen gas can be generated inside steel drums, tank cars, tank trucks, or metal storage tanks. As hydrogen is a flammable gas, explosive mixtures with air under certain conditions may result. Smoking, fires, or open lights should not be permitted near these containers. Other products include sulfur dioxide and sulfur trioxide.

CONDITIONS CONTRIBUTING TO HAZARDOUS POLYMERIZATION

VII DISPOSAL, SPILL OR LEAK PROCEDURES

AQUATIC TOXICITY (E.G. 96 HR. TLM):

Aquatic toxicity range set by EPA as Category C. (LC_{50} range = >10 to ≤ 100 mg/l). Reference 40 CFR § 118.

WASTE DISPOSAL METHOD

Store in area where spills or leaks can be contained and disposed of properly. Preferrably neutralize with lime or soda ash. The resulting sulfate salts may be diluted, land filled, or washed to sewage plants if local ordinances permit.

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED

Contaminated area should be thoroughly flushed down with large amounts of water and soda ash or lime spread over area to neutralize residual acidity. If spill is sufficient to contaminate sewer system, neutralize washings with soda ash or other alkaline material.

NEUTRALIZING CHEMICALS

Soda ash, lime, or other alkaline material.

VIII SPECIAL PROTECTION INFORMATION

VENTILATION REQUIREMENTS

Local exhaust ventilation may be necessary to limit employee exposure in processes liberating acid mist. Ventilation will also be necessary to clear storage tanks prior to entry. Follow OSHA regulations for tank entry.

SPECIFIC PERSONAL PROTECTIVE EQUIPMENT For acid gases and mist concentrations less than 10 times the TLV, a chemical cartridge respirator approved by NIOSH for acid gases and mists may be used. Use a full facepiece if eye irritation is noted. See reference (4). For emergencies or approved self-contained breathing apparatus in pressure demand mode with full facepiece.

Chemical safety goggles. Face shield may be worn.

GLOVES

Rubber gloves should be worn if body contact is possible.

CLOTHING AND EQUIPMENT

Rubber safety shoes, or rubbers worn over leather safety shoes. Wear rubber apron if body contact is possible.

IX SPECIAL PRECAUTIONS

PRECAUTIONARY STATEMENTS

Containers and carriers containing corrosive liquid must be properly labeled, placarde shipping papers, and transported in accord with Federal regulations contained in 49 CFR Parts 171 - 177, and other applicable Federal, State and Local regulations.

OTHER HANDLING AND STORAGE REQUIREMENTS

Hydrogen can be generated inside drums and tanks; therefore open lights, smoking or sparks should not be permitted near open drums or tanks. When diluting with water, add acid to water - never add water to acid. Do not allow water to enter storage tank as a violent reaction can occur.

ADDITIONAL REGULATORY CONCERNS

FEDERAL:

FDA, USDA: When used as a direct or indirect additive to foods or substances in contact with food substances.

CPSC: -

TSCA: IS THIS PRODUCT, OR ALL ITS INGREDIENTS, BEING CERTIFIED FOR INCLUSION ON THE TOXIC SUBSTANCES CONTRO INVENTORY OF CHEMICAL SUBSTANCES? Yes

OTHER: EPA when used as a pesticide.

STATE: Unknown.

PREPARED BY Dr. Arthur F. Gohlke

TITLE: Technical Marketing Associate

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APPENDIX

GLOSSARY OF COMMON TERMS

Absorption--The taking up of one substance into the body of another.

Acid--A compound, usually having a sour taste, which is able to neutralize an alkali or base; an ionizable compound of which the positive ions are hydrogen.

Acidity--A quantitative measurement of the total acid constituents of a water, both in the ionized and un-ionized states. Usually expressed as ppm of equivalent $CaCO_3$.

adsorption--The adherence or attachment of dissolved, colloidal or finely divided solids on the surface of solid bodies with which they are brough in contact.

Alkaline-- Water or soils containing sufficient amounts of alkaline substances to raise the pH above 7.0, or to harm the growth of crops.

Alkalinity--A term used to represent the content of carbonates, bicarbonates, hydroxides, and occasionally borates, silicates, and phosphates in water. It is expressed in parts per million of calcium carbonate.

Alum--The common name for aluminum sulfate, $Al_2(SO_4)_3 \times H_2O$ often used as a coagulant in water treatment.

Atomic Weight--The relative weight of an atom of an element with respect to the weight of oxygen, assumed to be 16.00.

Baffles--Deflector vanes, guides, grids, gratings or similar devices constructed or placed in flowing water to (1) Check or effect a more uniform distribution, or (2) To agitate or provide turbulence.

Base--An alkali or hydroxide of the alkali metals, and of ammonia, which neutralize acids to form salts and water. Ionizes to form $(ODH)^-$ions. A hydroxide. An alkali.

Basin, Sedimentation--A structure designed to hold water or sewage in a quiescent state or at a reduced velocity for a sufficient interval of time to permit the gravitational depositing of suspended matter, with or without the aid of previous flocculation or coagulation. Settling basin. Settling tank.

Bicarbonate--A salt of carbonic acid containing the $(HCO_3)^-$ radical.

Biochemical--Resulting from biologic growth or activity, and measured by or expressed in terms of the ensuing chemical change.

Biochemical Action--Chemical changes resulting from the metabolism of living organisms.

Biochemical Oxygen Demand (BOD)--The quantity of oxygen utilized in the biochemical oxidation of organic matter in a specified time and at a specified temperature. It is not related to the oxygen requirements in chemical combustion, being determined entirely by the availability of the material as a biological food and by the amount of oxygen utilized by the microorganisms during oxidation.

Biochemical Oxygen Demand, Standard--Biochemical oxygen demand as determinded under standard laboratory procedure for five days at 20°C, usually expressed in parts per million.

Buffer--The action of certain solutions in opposing a change of composition, especially of hydrogen-ion concentration.

Calcium--An element which occurs in water in the form of a compound and which is the most common cause of hardness. (Ca).

Calcium bicarbonate--A calcium salt of carbonic acid containing the $(HCO_3)^-$ radical; $Ca(HCO_3)_2$; the most common cause of hardness.

Calcium Carbonate--A crystalline compound, insoluble in water. Limestone, marble chalk, calcite. $CaCO_3$. The precipitate formed in the lime-soda ash softening process.

Calcium Hydroxide--Slake lime. $Ca(OH)_2$. Used in water treatment to remove carbonate or temporary hardness, and for pH control.

Calcium Oxide--Unslaked lime, CaO.

Carbon, Activated--Carbon particles usually obtained by carbonization of cellulos material in the absence of air and possessing a high adsorptive capacity. Used mainly for taste and odor control and removal of trace organics.

Carbonate--A salt of carbonic acid containing the $(CO_3)^-$ radical.

Caustic Soda--Sodium hydroxide. NaOH. Also called caustic.

Centigrade--Pertaining to the Centigrade thermometer scale; water freezes at 0°C and boils at 100°C.

Centimeter--One hundredth of a meter.

Centrifuge--A mechanical device utilizing centrifugal force to separate solids from liquids or for separating liquid emulsions.

Centrifugual--Moving or directed outward from the center.

cfs--A rate of flow, cubic feet per second.

Chemical Feeder--A device for feeding chemicals to water at a known, controlled rate.

Chlorine--An element ordinarily existing as a greenish yellow gas about 2.5 times as heavy as air. Used primarily for disinfection purposes. (Cl_2).

Coagulant--A material, which, when added to a water will cause coagulation to take place.

Coagulation--The gathering together of colloidal or finely divided suspended matter by the addition to the liquid of an appropriate coagulant.

Coagulation Basin--A basin or tank in which the coagulation-flocculation process takes place.

Detention Time--The theoretical length of time for water to pass through a basin or tank, if all the water moves through with the same uniform velocity; mathematically equal to the volume of basin divided by the rate of flow. Also called retention time, detention period, period of retention, etc.

Diatom--Any one of numerous miscroscopic, unicellular, marine or fresh water algae, having siliceous cell walls.

Diatomaceous Earth--A fine siliceous earth composed chiefly of cell walls of diatoms. Used as the standard of turbidity. Also used as a special filtering media in the diatomite filter.

Diatomite Filters--A filter employing diatomaceous earth as the filtering material.

Dilution--(1) A method of disposing of sewage, industrial waste, or sewage treatment plant effluent by discharging it into a stream or body of water. (2) The ratio of volume of flow of a stream to the total volume of sewage or sewage treatment plant effluent discharged into it.

Dissolved Solids--Solids that are present in solution.

Distributor--A device used to apply liquid to the surface of a filter or contact bed, of two general types, fixed or movable. The fixed type may consist of perforated pipes or notched troughs, sloping boards, or sprinkler nozzles. The movable type may consist of rotating disks or rotating, reciprocating, or traveling perforated pipes or troughs applying a spray, or a thin sheet of liquid.

Effective Size--The size of sieve which will permit 10% of the sand sample to pass but will retain the remaining 90%. A measure of the relative ability of a filtering material to permit the passage of water.

Efficiency--The ratio of the actual performance of a device to the theoretically perfect performance usually expressed as a percentage.

Average--The efficiency of a machine or mechanical device over the range of load through wich the machine operates.

Filter--The operating results from a filter as measured by various criteria such as percentage reduction in suspended matter, total soilds, biochemical oxygen demand, bacteria, color, etc.

Pump--The ratio of energy converted into useful work to the energy applied to the pump shaft, or the energy difference in the water at the discharge and suction nozzles divided by the energy input at the pump shaft.

Wire-to-Water--The ratio of the mechanical output of a pump, to the electrical input at the meter.

Effluent--Water flowing out of a reservoir, basin, or treatment plant, or part thereof.

Electrolyte--Any substance which dissociates into electrically charged particles, or ions, when dissolved in water.

Element--A substance which cannot be subdivided into simpler substances by ordinary chemical changes.

Electron--A particle having a negative electrical charge and which revolves about the nucleus of an atom.

Equivalent Weight--Combining weight.

Fahrenheit--Pertaining to the Fahrenheit thermometer scale. Water freezes at 32°F and boils at 212°F.

Ferric--Of or containing iron in the trivalent state. (Fe^{+++}).

Ferric chloride--One of the several iron salts used as a coagulant. $FeCl_3$.

Ferric Hydroxide--The floc formed by the normal reaction between one of the iron coagulants and the alkalinity of a water in the coagulation process. $Fe(OH)_3$.

Ferric Sulfate--One of the several iron salts used as a coagulant. $Fe_2(SO_4)_3$.

Ferrous--Of or containing iron in the divalent state. (Fe^{++}).

Ferrous Sulfate--One of the several iron salts used as a coagulant. Also called copperas. $FeSO_4 7H_2O$.

Filter--A device or structure for removing solid or colloidal material, usually of a type that cannot be removed by sedimentation.

Filter Rate Controler--An automatic device inserted in the effluent pipe of a filter to maintain the rate of flow constant throughout the filter run.

Filtration--The process of passing a liquid through a filtering medium (which may consist of granular material such as sand, diatomaceous earth, or specially prepared paper) for the removal of suspended or colloidal matter usually of a type that cannot be removed by sedimentation.

Filter Vacuum--A filter consisting of a cylindrical drum mounted on a horizontal axis, covered with filtering material made of wool, felt, cotton, saran, nylon, dacron, polyethylene or similar substance, by stainless steel coil springs or metal screen, revolving with a partial submergence in the liquid. A vacuum is maintained under the cloth for the larger part of a revolution to extract moisture. The cake is scraped off continuously.

Floc--Small gelatinous masses formed in a liquid by the addition of coagulants thereto.

Flocculation--The formation of flocs subsequent to the process of coagulation.

Flocculator--An apparatus for the formation of floc in water or sewage.

Flotation--A method of raising suspended matter to the surface of the liquid in a tank as scum--by aeration, by the evolution of gas, chemicals, electrolysis, heat, or bacterial decomposition--and the subsequent removal of the scum by skimming.

Gage--A device for measuring any physical magnitude.

Float--A device for measuring the elevation of the surface of a liquid, the actuation element being a buoyant float which rests upon the surface of the liquid.

Indicator--A gage that shows by means of an index, pointer, dial, etc., the instantaneous value of such characteristics as depth, pressure, velocity, stage, discharge, or the movements or positions of water-controlling devices.

Mercury--A gage wherein pressure of a fluid is measured by the height of a column of mercury which the fluid pressure will sustain. The mercury is usually contained in a tube, attached to the vessel or pipe containing the fluid.

Pressure--A device for registering the pressure of solids, liquids, or gases. It may be graduated to the register pressure in any units desired.

g.p.d.--Gallons per day.

Grade, Hydraulic--In a closed conduit under pressure, a line joining the elevations to which water would rise in pipes freely vented and under atmospheric pressure.

Grain--A unit of weight, 7000 units in a pound.

Grains per Gallons--A measure of the amount of a substance added to or dissolved in a known volume of water.

Gram--A metric unit of mass defined as one thousandth of a kilogram. Practically equal to the weight of a cubic centimeter of water.

Gram Equivalent Weight--The number of grams of a substance equal to the equivalent weight.

Head--Energy per unit weight of liquid at a specified point. It is expressed in feet.

Dynamic--The head against which a pump works.

Friction--The head lost by water flowing in a stream or conduit as the result of the disturbances set up by the contact between the moving water and its containing conduit, and by intermolecular friction. In laminar flow the head lost is approximately proportional to the first power of the velocity; in turbulent flow to a higher power, approximately the square of the velocity. While strictly speaking, head losses due to bend, expansions, obstructions, impact, etc., are not included in this term, the usual practice is to include all such head losses under this term.

Loss of--The decrease in head between two points.

Static--The vertical distance between the free level of the source of supply, and the point of free discharge, or the level of the free surface.

Total Dynamic--The difference between the elevation corresponding to the pressure at the discharge flange of a pump and the elevation corresponding to the vacuum or pressure at the suction flange of the pump, corrected to the same datum plane, plus the velocity head at the discharge flange of the pump, minus the velocity head at the suction flange of the pump. It includes the friction head.

Velocity--The theoretical vertical height through which a liquid body may be raised due to its kinetic energy. It is equal to the square of the velocity divided by twice the acceleration due to gravity.

Hydrogen--The lightest known gas, a constituent of all acids. H_2.

Hydrogen-Ion Concentration--The gram formula weights of hydrogen ions per liter of solution. Commonly expressed as the pH value.

Hydrogen Sulfide--A colorless gas, heavier than air. The odor in low concentrations is like rotten eggs. Formed by the reduction of sulfates. H_2S.

Hydrochloric Acid--The gas hydrogen chloride when absorbed in water forms hydrochloric acid. HCl. Also called muriatic acid.

Hydroxide--A compound which ionized to form $(OH)^-$ ions. A base; an alkali.

Impeller--The rotating part of a centrifugal pump, containing the curved vanes.

Closed--An impeller having the side walls extended from the outer circumference of the suction opening to the van tips.

Nonclogging--An impeller of the open, closed, or semi-closed type designed with large passages for passing large solids.

Open--An impeller without attached side walls.

Screw--The helical impeller of a screw pump.

Impervious--A term applied to a material through which water cannot pass or passes with great difficulty.

Influent--Water flowing into a reservoir, basin, or treatment plant, or a part thereof.

Ion--A particle, atom or group of atoms, carrying either a positive or negative electric charge, which is formed when an electrolyte is dissolved in water.

Ion Exchange--A process whereby water is passed through a granular material and ions of the granular material are replaced by ions contained in the water. For example, in the zeolite softening process the sodium ions (Na^+) of the granular zeolite are replaced by the calcium ions (Ca^{++}) in the water to leave the water free of calcium, the cause of hardness, but containing an equivalent amount of sodium.

Ionization--The process of the formation of ions by the splitting of molecules of electrolytes in solution. Dissociation.

Iron--An element which occurs in nature in the oxide form. Iron compounds, such as sulfates and chlorides, often are used as coagulants. As a compound it exists either in the divalent (ferrous) state (Fe^{++}), or the trivalent (ferric) state (Fe^{+++})

Jar Test--A laboratory test used to determine the optimum amounts of coagulant to be added for most efficient coagulation.

Kilogram--1000 grams.

Lateral--The smaller pipes of a filter underdrainage system which are connected to the main pipe, or manifold, and which contains orifices through which the filtered water flows.

Lime--Either calcium oxide, CaO, also called unslaked lime or calcium hydroxide, $Ca(OH)_2$, also called slaked lime. Used for the removal of carbonate or temporary hardness, and for pH control and heavy metal precipitation.

Liter--1000 milliliters, practically 1000 cubic centimeters.

Main, Force--A pipe line on the discharge side of a water or sewage pumping station, usually under pressure.

Manifold--The large, main pipe of a filter underdrainage system to which the laterals are joined.

Manometer--An instrument for measuring pressure; usually it consists of a U-shaped tube containing a liquid, the surface of which in one end of the tube moves proportionally with changes in pressure upon the liquid in the other end. The term is also applied to a tube type of differential pressure gage.

Matter--Solids, liquids, and gasses.
Inorganic--Chemical substances of mineral origin. They are not usually volatile with heat.
Organic--Chemical substances of animal, vegetable and industrial origin. They include most carbon compounds, combustible and volatile with heat.
Suspended--(1) Solids in suspension in sewage or effluent. (2) Commonly used for solids in suspension in sewage or effluent which can readily be removed by filtering in a laboratory.

Meter--A unit of length; 100 centimeters; 1000 millimeters.

mgd--Million gallons per day; a rate of flow.

Micron--One thousandth of a millimeter.

Milligram--One thousandth of a gram.

Milliliter--One thousandth of a liter; practically one cubic centimeter.

Moisture, Percentage--The water content of sludge expressed as the ratio of the loss in weight after drying at 103°C, to the original weight of the sample, multiplied by one hundred

Molecular Weight--The relative weight of a molecule of a substance with respect to the weight of oxygen assumed to be 16.00.

Nitrate--The stable oxidized form of a nitrogen compound containing the $(NO_3)^-$ radical.

Nitrite--An oxidized form of a nitrogen compound containing the $(NO_2)^-$ radical, from which is formed, by further oxidation or nitrification, the stable nitrate radical.

Normal Solution--One gram-equivalent weight of a substance dissolved in a liter of solution.

Nucleus--(1) The central part of an atom containing most of its mass and around which revolve the electrons. (2) A central part or thing about which other parts or things are grouped.

Organic--(1) Characteristic of, pertaining to, or derived from living organisms. (2) Pertaining to a class of chemical compounds containing carbon.

Organic Chemistry--The branch of chemistry dealing with the compounds of carbon, originally though to exist only in living organisms.

Orifice--An opening, usually relatively small, through which water may flow, generally used for the prupose of measurement or control of such water.

Oxidation--(1) The process of adding the element oxygen to a compound by chemical combination. (2) A chemical reaction which is accompanied by an increase in the positive valence, or the decrease of the negative valence, of an element. The opposite of reduction.

Oxide--A compound, usually containing two elements only, one of which is oxygen; the result from the oxidization of an element.

Oxygen--A colorless, odorless gaseous element, constituting about one fifth of the volume of the atmosphere and present in a combined state throughout nature. O_2. Atomic weight 16.00.

Parts per Million--Parts, by weight, in a million parts, also by weight, of solution. Grams per million grams, pounds per million pounds, milligrams per liter are typical illustrations. ppm, or mg/l.

Permeability--Perviousness.

Pervious--A term applied to a material through which water can pass with relative ease.

pH--The logarithm of the reciprocal of the hydrogen-ion concentration. It is not the same as the alkalinity and cannot be calculated therefrom. Varies from pH 1 to pH 14.

Phenol--Carbolic acid.

Pollution--The addition of sewage, industrial wastes, or other harmful or objectional material to water. A general term that does not necessarily signify the presence of disease producing bacteria.

Potable Water--Water which does not contain objectionable pollution, contamination, minerals or infection, and is considered satisfactory for domestic consumption. Suitable for drinking purposes.

Precipitate--To separate a substance, in the solid form, from a solution. The substance in solid form which has been separated out.

Precipitation--(1) The total measurable supply of water received directly from clouds, as rain, snow, hail, and sleet; usually expressed as depth in a day, month or year, and designated as daily, monthly, or annual precipitation. (2) The phenomenon which occurs when a substance held in solution passes out of solution into solid form.

Pressure--(1) The total load or force acting upon a surface. (2) In hydraulics the term, when used without qualification, usually means pressure per unit area or "intensity" of pressure. For example, pounds per square inch, kilograms per square centimeter, above atmospheric pressure.

Atmospheric--The pressure exerted by the atmosphere at any point. Such pressure decreases as the elevation of the point above sea level increases. One atmosphere is equal to 14.7 lb. per sq. in., 29.92 in. or 760 mm of mercury column or 33.90 ft. of water column at average sea level under standard conditions.

Hydrostatic--The pressure, expressed as a total force per unit of area, exerted by a body of water at rest.

Negative--A pressue less than the local atmospheric pressure at a give point.

Pump--A device used to increase the head on a liquid.

Booster--A pump installed on a pipe line to raise the pressure of the water on the discharge side of the pump.

Centrifugal, Fluid--A pump consisting of an impeller fixed on a rotating shaft and enclosed in a casing, having an inlet and a discharge connection. The rotating impeller creates pressure in the liquid by the velocity drived from centrifugal force.

Centrifugal, Screw--A centrifugal pump having a screw-type impeller; may be axial-flow, or combined axial and radial-flow type.

Centrifugal, Closed--A centrifugal pump where the impeller is built with the vanes enclosed within circular disks.

Diaphragm--A pump in which a flexible diaphragm, generally of rubber, is the operating part; it is fastened at the outer rim; when the diaphragm is moved in one direction, suction is exerted and when it is moved in the opposite direction, the liquid is forced through a discharge valve.

Double-Suction--A centrifugal pump with suction pipes connected to the casing from both sides.

Duplex--A reciprocating pump consisting of two cylinders placed side by side and connected to the same suction and dishcarge pipe, the pistons moving so that one exerts suction while the other exerts pressure, with the result that the discharge from the pump is continuous.

Horizontal Screw--A pump with a horizontal cylindrical casing, in which operates a runner with radial blades, like those of a ship's propeller. The pump has a high efficiency at low heads and high discharges, and is used extensively in drainage work.

Mixed Flow--A centrifugal pump in which the head is developed partly by centrifugal force and partly by the lift of the vanes on the liquid.

Open Centrifugal--A centrifugal pump where the impeller is built with a set of independent vanes.

Propeller--A centrifugal pump which develops most of its head by the propelling or lifting action of the vanes on the liquids.

Purification--The removal, by natural or artificial methods, of objectionable matter from water.

Quicklime--A calcined material, the major part of which is calcium oxide or calcium oxide in natural association with a lesser amount of magnesium oxide, capable of being slaked with water. Unslaked lime.

Radical--A group of atoms, within the molecule of a compound, which react chemically as a single atom.

Rate of Flow--The volume of water per unit of time which is passing a certain observation point at a particular instant. Common expressions are cubic feet per second (cfs), gallons

per minute (gpm), gallons per day (gpd), million gallons daily (mgd).

Rate of Flow Controller--An automatic device inserted in a pipe to control the rate of flow at a constant value.

Reduction--The opposite of oxidation.

Saturation--The condition of a liquid when it has taken into solution the maximum possible quantity of a given substance at a give temperature and pressure.

Sedimentation--The process of subsidence and deposition of suspended matter from water by gravity. It is usually accomplished by reducing the velocity of the liquid below the point where it can transport the suspended material. Also called settling or clarification.

Sewage--Largely the water supply of a community after it has been fouled by various uses. From the standpoint of source it may be a combination of the liquid or water-carried wastes from residences, business buildings, and institutions, together with those from industrial establishments, and with such ground water, surface water, and storm water as may be present.

Sewer--A pipe or conduit, generally closed, but normally not flowing full, for carry sewage and other waste liquids.

Sewerage--A comprehensive term which includes facilities for collecting, pumping, treating, and disposing of sewage; the sewerage system and the sewage treatment works.

sludge--The accumulated settled solids deposited from sewage or industrial wastes, raw or treated, in tanks or basins, and containing more or less water to form a semiliquid mass.

Slurry--A suspension of small undissolved particles in a very high concentration.

Soda Ash--A common name for sodium carbonate. Na_2CO_3. Used to remove non-carbonate or permanent hardness and for alkalinity or pH adjustment.

Sodium Hydroxide--Also called caustic soda. NaOH.

Solids--Material in the solid state.
Dissolved--Solids which are present in solution.
Nonsettleable--Finely divided suspended solids which will not subside in quiescent water, sewage, or other liquid in a reasonable period. Such period is commonly, though arbitrarily, taken as two hours.

Settleable--Suspended solids which will subside in quiescent water, sewage, or other liquid in a reasonable period. Such period is commonly, though arbitrarily, taken as one hour. Also called Settling Solids.

Suspended--The quantity of material deposited when a quantity of water, sewage, or other liquid is filtered through an asbestos mat in a Gooch crucible.

Total--The solids in water, sewage, or other liquids; it includes the suspended solids (largely removable by filter paper), the filterable solids (those which pass through filter paper), and the disolved solids.

Volatile--The quantity of solids in water, sewage, or other liquid, lost on ignition of the total solids.

Solids, Contact Process--The name given to the process of chemical mixing, coagulation, flocculation and sedimentation when carried on in a single tank in such a manner that the mixed chemicals are introduced into a zone of already precipitated floc which serve as nuclei for further floc formation.

Solute--The substance dissolved in a give solution.

Solution--A gas, liquid, or solid dispersed homogeneously in a gas, liquid or solid without chemical change.

Solvent--The liquid into which another substance is dissolved.

Standard Methods--Methods of analysis of water, sewage,and sludge approved by a Joint Committee of the American Public Health Association, American Water Works Association, and Water Polution Control Association.

Standard Solution--A solution containing a known quantity of a single substance used in various laboratory analysis.

Suspended Solids--All visible material in water which at the time of sampling is not dissolved, and which can be removed by filtration.

Suspension--A system consisting of small particles kept dispersed by agitation or by molecular motion in the surrounding water. The permanency of suspension is dependent on the degree of agitation and/or the size of particles. A colloid is a special kind of suspension.

Tank--A circular or rectangular vessel.

Treatment--Any definite process for modifying the state of matter.

Turbulence--A state of flow of a liquid wherein the liquid is agitated by cross currents and eddies.

Unit Pressure--The pressure or force created by a material body or liquid per unit area exposed to contact. Also calle pressure intensity.

Unit Weight--The weight of a unit volume of material, such as pounds per cubic foot or per cubic inch.

Valence--The relative combining ability of an element or a radical as represented by the number of electrical charges held by the element or radical.

Venturi Meter--A meter for measuring the rate of flow of a liquid through closed conduits or pipes, consisting of a Venturi tube and one of several proprietary forms of flow registering devices.

Venturi Tube--A closed conduit or pipe containing a gradual contraction, which causes a reduction of the pressure head, producing a difference of pressure which can be determined. The contraction is generally followed, but not necessarily so, by an enlargement to the original size. The pressure differential thus produced can be used to determine the flow.

Volatile--Passing off readily in the form of a vapor.

Water--A chemical compound consisting of two parts of hydrogen and one part of oxygen by volume. It may have other solid, gaseous, or liquid materials in solution or suspension. H_2O.

Weir--An obstruction placed across a stream or other flowing water so as to cause the water to pass through an opening or notch, thus allowing the quantity of water to be measured.